Teaching science outside the classroom: the role of teachers' beliefs and teacher efficacy during a two-year professional development programme

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Abstract

Teaching outside is an important pedagogical strategy, however it is rare to find a secondary science teacher who uses the technique more than occasionally. This thesis explores the role that science teachers' beliefs and teacher efficacy have on their pedagogical practice outside the classroom. Furthermore, in the context of a two-year outdoor science professional development programme underpinned by a social constructivist pedagogical framework, the study investigates professional development strategies influential on teachers' beliefs and teacher efficacy and eventual pedagogical practice.

The study's methodology was situated within a qualitative interpretative/social constructive paradigm. The thesis includes six case studies of participants who completed the outdoor professional development programme and who implemented outdoor science activities into their teaching. Data (including teacher interviews, lesson observations and session evaluations) informing the case studies were collected throughout the programme. Analytical frameworks were developed from the research literature for science teachers' beliefs and teacher efficacy.

Teachers' beliefs and teacher efficacy appeared to be influential on outdoor pedagogical practice. For example, teachers' more general beliefs concerning how children learn influenced more specific beliefs relating to teaching and learning science outside with both types of beliefs influencing the teachers' pedagogical decision-making outside. Furthermore, teachers' beliefs and teacher efficacy relating to managing student learning outside appeared to influence pedagogical practice. Finally, in terms of professional development strategies, in-school factors (such as teaching activities outside and working with a colleague), alongside programme session strategies (such as tutor-led simulated modelling) appeared to be important factors facilitating change. Teachers' beliefs and teacher efficacy appeared to influence the effectiveness of specific professional development strategies on pedagogical practice.

The findings of this thesis suggest that science teachers' beliefs and teacher efficacy influence pedagogical practice outside. Furthermore, particular professional development programme strategies are more influential on teachers' practice when particular beliefs or levels of teacher efficacy are identified.

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Abbreviations

A-level	General Certificate of Education Advanced Level
AfL	Assessment for Learning
ASE	Association of Science Education
AZSTT	AstraZeneca Science Teaching Trust
BES	British Ecological Society
CA	Cognitive Acceleration
CASE	Cognitive Acceleration through Science Education
CEO	Chief Executive Officer
CPD	Continual Professional Development
DES	Department of Education and Skills
DfEE	Department for Education and Employment
DfES	Department of Education and Skills
DoE	Department for Education
EOtC	Education Outside the Classroom
FSC	Field Studies Council
GCSE	General Certification of Secondary Education
GTP	Graduate Teacher Programme
HoD	Head of Department/Science
ID	Instructional Discourse
INSET	In-service Training
ITE	Initial Teacher Education
KS3/4	Key Stage 3 (11-14 years)/Key Stage 4 (14-16 years)
LA	Local Authority
LEA	Local Education Authority

NCTL	National College for Teaching and Leadership
NGO	Non-Governmental Organisations
OECD	Organisation for Economic Co-operation and Development
OED	Outcome Expectancy Dimension
Ofsted	Office for Standards in Education, Children Services and Skills
PCK	Pedagogical-Content Knowledge
PD	Professional Development
PGCE	Post Graduate Certificate in Education
PSTE	Personal Science Teaching Efficacy dimension
RD	Regulative Discourse
RPTE	Researcher's Perception of Teacher Efficacy
SATs	National Curriculum assessments
SED	Perceived Self-Efficacy dimension
STEM	Science, Technology, Engineering and Mathematics
STOE	Science Teaching Outcome Expectancy dimension
STEBI	Science Teacher Efficacy Beliefs Instrument
TA	Teacher Agency
TDA	Teacher and Development Agency
TTA	Teacher Training Agency
ZPD	Zone of Proximal Development

Chapter 1 Introduction

1.1 Background to the research

> At the heart of our plan is a vision of the teacher as our society's most valuable asset.
> We know nothing matters more in improving education than giving every child access to the best possible teaching. (Department for Education, 2010a: 7)

In 2010, the UK's Coalition Government came to power sure in their belief that paramount to achieving an outstanding education system was a high quality teaching profession. *The Importance of Teaching,* the White Paper from which the extract above is taken, identifies that for the English school system to achieve high quality teaching, an improved organisation of professional development is required. Effective qualities in teachers are, to some extent, context specific and are not easily defined (Kennedy, 2010). A broad sense of how a teacher might be judged effective can be elicited from the Government's Teachers' Standards (Department for Education, 2012):

> Teachers make the education of their pupils their first concern, and are accountable for achieving the highest possible standards in work and conduct. Teachers act with honesty and integrity; have strong subject knowledge, keep their knowledge and skills as teachers up-to-date and are self-critical; forge positive professional relationships; and work with parents in the best interests of their pupils. (p.7)

This extract draws into sharp focus the idea that alongside personal attributes such as concern, honesty and integrity, effective teaching requires keeping up-to-date with subject knowledge, general teaching knowledge and skills. In a context of continuous education reforms, curriculum changes and a school subject's evolving knowledge, what constitutes effective teaching is ever-changing, hence the requirement for on-going professional development (Guskey, 2000).

The active promotion of teaching students outside the classroom is an example of a recent educational change requiring teacher response. Over the last decade, the momentum has been building to increase opportunities for student learning outside the classroom. In the US, for example, this change can be recognised in the growth of the 'No Child Left Inside' movement (for example, No Child Left Inside Coalition, 2013). In England, it was evident in the creation of the Council for Learning Outside the Classroom which was initiated by government (Department of Education and Skills, 2006). The Manifesto for Learning Outside the Classroom states that:

> Learning outside the classroom is about raising achievement through an organised, powerful approach to learning in which direct experience is of prime importance. This is not only about what we learn but importantly how and where we learn. (DfES, 2006: 3)

Enabling a 'powerful approach to learning' in the outdoors has generally been considered as a joint enterprise between schools and the natural environment sector (for example, field study centres and outward bound centres). However, when the contexts for learning outside are school grounds and local parks, teaching responsibility usually resides with the school. Dillon and Dickie, in a report commissioned by Natural England, note that:

> [...] schools have the potential to inspire and enthuse young people, to provide them with memorable experiences and to empower them to make the most of the natural spaces and places locally and further afield. (2012: 1)

The authors acknowledge that whilst a combination of school factors enables students to learn outside (for example, school systems and senior staff teams), vital to success is an effective teacher. This finding, that teachers are central to students' access and experience of learning outside, chimes with Rickinson *et al.*'s (2004) meta-analysis findings (discussed below). As to the variation between the effectiveness of learning experiences outdoors experienced by students in different schools and classes, the findings of research studies such as Dillon and Dickie (2012), Nundy *et al.* (2009) and Glackin (2006) concur with the Office for Standards in Education, Children Services and Skills (Ofsted) (2004; 2008), that teacher confidence is fundamental. Confidence is a general term, teacher efficacy, however, is specific, concerning future judgements of achievement. Henceforth, where appropriate, the term teacher efficacy will be used instead of teacher confidence (this issue is discussed further in Chapter 3).

Teacher efficacy in using a particular pedagogical practice is enmeshed in experience – being both informed by and informing teacher beliefs. Gilbert (2010), commenting on teachers' professional development needs, highlights the fact that secondary science teachers enter the profession through multiple routes with various subject backgrounds. Furthermore, when training to enter the profession, Kendall *et al.* (2006) report that pre-service teachers' exposure to teaching and/or learning outside varies substantially. Teacher education in outdoor learning has been described as haphazard and accused of maintaining deficiencies in expertise resulting in the concomitant lack of confidence (Assocation of Science Education Outdoor Science Working Group, 2011), which led the Association of Science Education (ASE) Outdoor Science Working Group (2007; 2011) to call for a standardised professional development offer for all pre- and in-service science teachers.

It was in this context and climate that an outdoor science professional development programme was developed – one which has provided the focus of this thesis. 'Thinking Beyond the Classroom', a professional development programme funded by the AstraZenca Science Teaching Trust (AZSTT), was aimed at enhancing in-service secondary science teachers' pedagogy outside the classroom. (In June 2013 the Trust became The Primary Science Trust). Over a two-year period (2007-09), science teachers from 10 science departments in London schools attended up to six three-hour professional development sessions and received a minimum of two school observations from programme tutors. Ten lesson activities were developed that were underpinned by two pedagogical approaches with evidence for enhancing student learning – Cognitive Acceleration through Science Education (CASE) (Shayer and Adey, 2002) and Assessment for Learning (AfL) (Black and Wiliam, 1998). The activities that were developed and piloted during the programme acted as a focus for the teacher development (see Chapter 4). By way of background, the following section outlines what is meant in this thesis by outdoor science learning, describes the associated affordances for student learning and identifies known barriers for its incorporation into science lessons.

1.1.1 Outdoor science learning

The terms 'Learning outside the classroom' and 'outdoor learning' might appear to have morphed and be used synonymously in the preceding section; however this is not the case. With the advent of the Manifesto, 'Learning outside the classroom' became an umbrella term encompassing all student activities out of the classroom – for example, visits to museums, science centres, religious and historic buildings, field centres, parks and school grounds (DfES, 2006). 'Outdoor learning' involves students learning within an open space beyond the constraints of a building, for example, field centres, parks, school grounds. The focus of this thesis is on 'outdoor science learning'; a term preferred to 'fieldwork'. Fieldwork, which has its foundations in Victorian times and nature study, was historically ring-fenced as the biological study of natural history and ecology (for example, Gayford, 1985). More recently, fieldwork has been used to include all sciences, especially with a focus on experimental skills (for example, Lock, 1998; ASE, 2011), however its original affiliation with biology still exists, a narrowness this study was designed to avoid.

Taking science outside, rather than leaving it in the classroom, offers different opportunities for learning. Identifying and differentiating individual contexts unique influence on learning is challenging (Falk and Dierking, 2000). That said, if learning is considered as socially constructed, an underlying assumption would be that prior experiences will be added to or drawn upon - thus informing new understandings. Hence, attempting to differentiate learning locations is futile when the context's role is considered to enable new connections or deepen previous understandings. Building on Bloom *et al.'s* (1956) 'domains' or types of learning, Rickinson *et al.'s* (2004) meta-analysis, based upon 150 studies published in English from 1993 to 2003, divided research findings on the impacts on student learning outside the classroom into four types: cognitive, affective, social/interpersonal and physical/behavioural. Using Rickinson *et al.'s* categorisations, Table 1-1 summarises examples of recent research findings supporting learning outside the classroom (see Appendix 1 for an extended analysis).

Table 1-1 Research supporting learning outside the classroom

Educational benefit (Rickinson *et al.* 2004)	**Examples of research findings concerning learning outside the classroom**	**Example of research supporting finding**
Cognitive	Handling organisms or objects within the habitat can offer new skills of observation and categorisation	Leinhardt and Crowley (2002)
Affective	Engender increased levels of enjoyment acting to motive learning	Fägerstam and Blom (2013)
Social/interpersonal	The outdoors often offers opportunities to work independently - resulting in an increase in students' self-esteem, self-confidence and general levels of trust in others	Amos and Reiss (2006)
Physical/behavioural	Outside behaviour is better, or as good as, that in the classroom	Amos and Reiss (2012)

It is acknowledged that the examples above for each educational benefit are 'best fit' and it is recognised that their influence might be observed across other categories (see Glackin (2006) and King and Glackin (2010) for an extended discussion of the literature concerning the affordances for student learning outside the classroom).

Research findings supporting learning outside, such as those summarised in Table 1-1, have emerged from research contexts including residential field courses and more general out-of-classroom settings. Broadly, these findings are considered generalizable to other outdoor learning contexts. At present, limited research is available on the benefits of learning science specifically in the school grounds and local parks – the context for this research study. However borrowing from the research fields of outdoor education, human geography and environmental psychology, two further affordances of learning in local spaces are evident. The first benefit is the continuity relating to teaching, whereby the normal class teacher integrates and connects learning from the classroom to the outdoors and back. Due to the outdoor site being in such close proximity – just outside the door – the requisite pre-planning can be completed with ease. As Thorburn and Allison (2010: 101) suggest, the school-based approach to outdoor learning is 'low in risk and high in transfer value' where risk is considered as the level of technical difficulty, cost and ease to deliver by the majority of teachers. Conversely, 'high in risk and low in transfer value', the authors argue, is often expensive and time-demanding residential centre provision which might be disconnected to school-based learning due, for example, to unfamiliar specialist centre tutors.

The first benefit above is associated with the development of a student's identity, security and sense of belonging (Jack, 2010). The second benefit, more specific to science teaching, concerns the strong relationship reported between a student's use of space and the development of rules, and meaning of the space within particular cultures (Rappaport, 1978). For example, in England, the school grounds are often associated with physical activity, in particular athletics, football and hockey. This situation influences the students' formation of rules specific to the space in terms of how they act in it and the associations they make with it. Developing on Rappaport's (1978) theory, I postulate that if science lessons were more frequently conducted outside, students might develop 'scientific' associations with the space. In the longer term, these associations might result in a broader identity of science – no longer restricted to laboratory practice. Put another way, learning outdoors might enable teachers to:

> […] focus on helping learners deal with the sheer complexity and splendour of the environment as well as looking to use the local environment as a vehicle for developing understanding of the more mundane aspects of the science curriculum. (Dillon and Scott, 2002: 1112)

1.1.2 Outdoor science teaching

Dillon and Dickie (2012:1), in the extract above (Section 1.1), claimed that 'schools have the potential to inspire' by making 'the most of the natural spaces and places locally', however although there is some local variation between science departments and their teachers (Glackin, 2007), in general, compared to other subjects, secondary science lessons in England infrequently occur outside (O'Donnell *et al.*, 2006). Furthermore, it is often claimed that the frequency of teaching outside has declined – a claim usually specific to biology/ecology fieldwork, rather than science in general (for example, Barker *et al.*, 2002).

That said, recent research is more sceptical (Lock, 2010), with some authors claiming there is little evidence of such a trend (O'Donnell *et al.*, 2006), the underuse being an invariant historic artefact.

A potential outcome resulting from the under-use is that little research has been completed concerning effective pedagogies for science teaching outside. Dillon (2011) suggests that 'this might explain why so much outdoor education is rather conservative in its approach' (p.1092), and, it could be argued, why it serves to maintain the *status quo*. Accepting low provision of outdoor science learning (including ecology) as historic, contemporary reasons reported by teachers for under-use are open to question. Such reasons include curriculum changes, increased health and safety regulations and lack of time/money/resources (for example, Lock, 2010). Furthermore, why some science departments/teachers are able to circumvent such barriers, whilst others are not, remains unclear (Dillon and Dickie, 2012).

One reason for the uncertainty about the nature of the barriers might reside in the methods used to collect the data. This supposition emerged from an earlier study of outdoor science teaching across secondary schools in five London boroughs (Glackin, 2006). When teachers were originally asked, via a postal-questionnaire, to list barriers and affordances of outdoor science, responses were similar to those listed above (Glackin, 2006). However, when data collection methods changed to include extended semi-structured interviews, school/field observations and informal conversations, teachers' confidence concerning pedagogical practice and managing student learning emerged as a dominant theme. These findings were consistent with anecdotal findings from a related project ('Schools in the Park') (Glackin and Jones, 2012).

A further reason for science teachers' underuse of the outdoors may be related to their beliefs. Returning to Rappaport's (1978) assertion that particular associations might be made with a space, science teachers might well have particular beliefs about the relationship between science and the outdoors. Furthermore, of particular importance to this study's context, Anderson (2002), commenting on pedagogical reforms, notes the role beliefs have on successful implementation:

> […] much of the difficulty [in enacting reform] is internal to the teacher, including teachers' beliefs and values related to students, teaching, and the purposes of education. (Anderson, 2002: 7)

1.1.3 Science teachers' outdoor professional development

Research suggests a relationship between teacher efficacy to teach outside and the extent of professional development received (O'Donnell *et al.,* 2006). For example,

> Teachers who appeared more confident in providing education outside the classroom (EOtC) activities were more likely, than teachers who were less confident, to have undertaken a greater number of activities over 2005/6 academic year.
> […]
> In secondary schools, subject heads [questionnaire responders] who received more training (initial teacher training or subsequent) in relation to EOtC were significantly more likely to have offered a greater number of school-site activities, off-site day visits and UK residential experiences than teachers with lower levels of training. (O'Donnell *et al.,* 2006:16-17)

Kendall *et al.* (2006), reporting on pre-service teachers' out-of-classroom provision found substantial variance in the level of practical experience offered. Furthermore, over half the pre-service secondary science course directors who responded to their survey thought that partnership schools were primarily responsible for practical experience in out-of-classroom contexts; the majority of respondents reported limited knowledge of the school-based provision. As to in-service provision, O'Donnell *et al.* (2006) report that over half of the responding secondary heads of science had never received outdoor professional development. It was from this varied landscape of outdoor professional development provision that teachers participating in the 'Thinking Beyond the Classroom' programme arrived.

The research literature concerning teachers' professional development in outdoor learning emphasises the number of training hours required rather than suggesting successful content or structures (for example, O'Donnell *et al.,* 2006). This emphasis on quantity is potentially the result of the lack of research into effective outdoor teaching. However, where content has been discussed, examples of effective strategies include: sharing outdoor activities and discussion of the requirement for pre- and post-outdoor work (for example, ASE, 2007, Glackin, 2006). Although strategies are useful, if effective outdoor professional development programmes are to be developed and replicated, a greater understanding is required of the theoretical frameworks used to develop effective programmes. Furthermore, if teacher efficacy and beliefs influence pedagogical decisions and professional development implementation, attempting to identify whether particular strategies are influential on teachers with similar beliefs or levels of teacher efficacy may enable the development of more successful programmes.

In summary, the main points emerging from the discussion above include that vital to student learning are effective teachers. To be effective, teachers are required to adapt and change in response to education and curriculum reforms. Learning outside the classroom is an example of an education reform requiring teacher pedagogical change. Some science teachers are able and willing to teach outside. Many, however, are not, which research has suggested might be due to confidence – or teacher efficacy. More generally, beliefs have also been noted to act as barriers to educational reforms. Professional development, through multiple forms, enables teachers to remain effective. Although there is a vast amount of literature around teachers' professional development, there appears to be a gap in knowledge concerning strategies enabling science teachers' outdoor pedagogical practice. Furthermore research is limited on the influence of science teachers' beliefs and teacher efficacy on effective professional development and resulting outdoor pedagogical practice.

1.2 Overview of the research

In light of the discussion above, the aim of this study was to explore the relationships between science teachers' beliefs, teacher efficacy and pedagogical practice during the two-year professional development programme associated with the 'Thinking Beyond the Classroom' project. In so doing, the research had two aspirations. First, to provide a deeper understanding of the role that teacher efficacy and beliefs had on science teachers' pedagogical decisions concerning teaching science outdoors. Second, to illuminate professional development factors and strategies, based on existing theories and research findings, which were considered influential on teachers' pedagogical practice to use the outdoors. In setting out to investigate such a relationship, the research questions were:

1. What is the interplay between teachers' beliefs, teacher efficacy and pedagogical practice?
2. What professional development strategies are significant in influencing teachers' practice?
3. How do teachers' beliefs and teacher efficacy influence responses to professional development programme strategies identified as significant in changing practice?

These research questions were explored in the context of the two-year professional development programme – 'Thinking Beyond the Classroom'. Within this setting, in order to address these questions, a social constructivist/interpretative methodological enquiry was conducted. Six case studies were constructed around teachers who had completed the programme. The case studies focused on teachers' beliefs, teacher efficacy, reaction to professional development strategies and the implementation of the outdoor science activities. To this end, the data collected included – professional development session field-notes, professional development session evaluations, lesson observations and teacher interviews. The data were collected on multiple occasions over the two years. This approach provided a method to substantiate what was reported (either observed, spoken or written) whilst offering insight into changes of beliefs, teacher efficacy and pedagogical practice.

1.3 Significance of the research

Over the past decade, calls have been made for 'higher levels of training' (O'Donnell *et al.,* 2006: ii) and 'good programmes and practices' (Rickinson *et al.*, 2004: 54). Practical guidance, however, has been less available in terms of what qualifies as 'good' or 'well-trained' and how teachers and professional development programmes might be judged, a situation which led Thorburn and Allison (2010: 104) to comment that,

> teachers whose beliefs are not inclined toward learning outdoors might use the continuing lack of support on curriculum and pedagogical matters as a justification to continue learning predominantly indoors.

By understanding more about the individual teacher, this study aims to contribute to both theory and practice in the contexts of secondary science teachers' outdoor pedagogical practice and professional development, both in general, and specifically for outdoor science education.

In terms of theory, this thesis offers a naturalistic social constructivist approach on teacher efficacy, one Wheatley (2005) highlights as significantly absent from current research dominated by quantitative methods. Hence, due to the limited frameworks currently developed, the study will provide a new analytical tool for teacher efficacy in science teaching outdoors. Furthermore, much current teacher efficacy literature seems to have been conducted in North American and Australian classrooms, attending to primary and pre-service teachers. This study should provide an original perspective in that it was conducted in England and focused on in-service secondary science teachers' pedagogical decisions relating to outdoor science teaching.

In terms of practice, the thesis findings should be beneficial to teacher educators/professional development providers and school professional development organisers (often members of school's senior staff teams). That is, it will aim to provide insight into the relationship between teachers' beliefs and teacher efficacy and professional development programmes' implementation so that school factors and professional development strategies that might enhance programme effectiveness might be replicated.

Finally the significance of the research is personal. I am passionate, as a teacher educator, that students should have the opportunity to learn science outside. This learning, however, should not become a further requirement, simply added to the Ofsted inspection list, whereby teachers feel it is another hoop to jump through, an action divorced from their own pedagogical choice. Rather, as set out earlier (Section 1.1.1) I believe outdoor experience can enhance science learning whilst anchoring students to their everyday world (for example, Lock (1998) and Jack (2010)). Teachers – as earlier stated – are the most valuable assets enabling this process to happen. Working with pre-service science teachers with a range of experiences, beliefs and values, I want to understand why some embrace the outdoor pedagogy whilst others require more persuasion. Furthermore, to develop my own teaching, I want to understand how and why some school factors and professional development programme strategies are effective – but not all of the time.

1.4 Chapter overview

This chapter has so far set out the rationale for the thesis. Literature was reviewed concerning learning and teaching science outdoors, and related professional development opportunities were discussed. Science teachers' beliefs and teacher efficacy were noted as important in teachers' decisions to use the outdoors. Hence, a need emerged to better understand how these components were influential on both practice and professional development programme effectiveness. Alongside the thesis' overarching aim and three guiding research questions, were the study's anticipated practical and theoretical contributions.

Chapter 2 broadly foregrounds the research concerning professional development and teacher change. To contextualise the study, following the conceptualisation of professional development, a historical/political outline for professional development in England is given. Several professional development models are explored. The models suggest that teachers' understanding and reactions to professional development are influenced by: themselves (micro-level), their school contexts (meso-level) and wider professional structures (macro-level). Similarly all three 'agents' inform the content and structure of teachers' professional development. Chapter 3, then, focuses in on the literature of the micro-level, reviewing what is understood by teachers' beliefs and teacher efficacy. The chapter explores teachers' beliefs and teacher efficacy relationships with pedagogical practice and professional development implementation.

Chapter 4 describes the pedagogical framework that underpinned the programme activities, and then outlines the design of the two-year professional development programme. The methodology and methods are set out and justified in Chapter 5. The interpretative approach taken is discussed, as are methods for data collection and analysis. Hence, a detailed description is offered of the construction of the analytical frameworks.

Chapter 6 presents six case studies of teachers who completed the two-year professional development programme. Data, including observations, interviews, field-notes and professional development session evaluations, are interwoven. Whilst each case study offers a description of the teaching context and previous outdoor teaching experiences, the focus of the case study is on the individual's beliefs, teacher efficacy, programme implementation and how the programme was experienced.

Chapters 7 and 8 compare and contrast the six case studies to respond to the research questions. Chapter 7 presents the emerging themes relating to the beliefs/pedagogical practice and teacher efficacy/pedagogical practice in implementation of the outdoor science activities, before exploring their interrelationship. Chapter 8 examines the programme strategies emerging as significant in influencing teachers' practice. Finally, Chapter 9 summarises the preceding two chapters' findings, before addressing the third research question and responds to the overarching research aim. Implications, recommendations and limitations of the work are considered, raising questions for future research.

Chapter 2 Teacher Professional Development

2.1 Introduction

Relatively few science teachers teach outside (O'Donnell *et al.*, 2006). As a result, the learning benefits the outdoors offer have been unavailable to the majority of secondary school students. Deciding whether to incorporate the outdoors into science lessons is just one of the multiple pedagogical decisions teachers make everyday. These decisions, filtered by their beliefs and their teacher efficacy (explored in Chapter 3), are a result of previous experiences including their professional development.

Chapter 1 highlighted the Governments focus on teacher professional development as a tool to enable students to gain access to high quality education (Department for Education, 2010a). The requirement for professional development is three-fold. First, science teachers enter the profession through different routes (for example, the Post Graduate Certificate in Education (PGCE), Teach First, Graduate Teacher Programme (GTP) (now School Direct)) and with a variety of scientific and academic backgrounds (for example, biology, chemistry, physics and bachelors degrees and Master's-level degrees) (Gilbert, 2010). Second, there are always new aspects of teaching and of the subject taught to explore, especially as both knowledge bases rapidly expand. Third, for transformative education reforms to be achieved (government-led or otherwise), teacher engagement and implementation are paramount (Guskey, 2000). This research study is motivated by a pragmatic concern with developing science teachers' repertoire so that they might choose to take advantage of teaching outside. Therefore understanding how professional development is effective in influencing pedagogical decisions is important.

Professional development has been described as conceptually vague (Coffield, 2000), ambiguous and contested (Friedman and Philips, 2004). However, evident in the literature are two interlinked premises. Firstly, professional development is a continuous process, informed by an accumulation of experiences (often unplanned), and secondly, professional development is an activity with purposeful and focused outcomes to be achieved or acquired (normally planned) (for example, Bell and Gilbert, 1996; Evans, 2002; Fraser *et al.*, 2007). Much professional development literature focuses on the latter premise, possibly as a consequence of it being an aspect that can be directly influenced. However, recognised in this study's research questions is the importance of both premises – planned and unplanned – on teachers' pedagogical practice. That is, the research whilst initially focused on identifying planned effective professional development strategies, later sought to identify the role teachers' beliefs and teacher efficacy have on programme implementation – components shaped by planned and unplanned professional development experiences (discussed further in Chapter 3).

Due to the limited literature concerning outdoor science professional development *per se,* this chapter reviews the professional development literature more broadly, focusing on science education related research where available. Following a discussion about how professional development is conceptualised, a historical/political overview of professional development in England is outlined. Both discussions serve to contextualise the study, the professional development experiences of the case study teachers and the limitations for any recommendations emerging from the research findings.

In response to the complexity of teacher professional development, multiple professional development models have been developed – three are described and critiqued. The models highlight the fact that teachers' understanding and reactions to professional development are influenced by: themselves (micro-level), their school context (meso-level) and wider professional structures (macro-level). Similarly, all three agents inform the content and structure of teacher professional development. Hence, although the focus of the study is on the micro-level (the influence of the individual teacher), features of all three levels of professional development are explored.

2.2 Teacher professional development: the idea and the history

2.2.1 Conceptualising professional development

2.2.1.1 Professional development as learning

Professional development is concerned with learning. Learning at its broadest can be understood from two perspectives – psychological and sociological. From a psychological perspective, learning is a cognitive process involving knowledge construction. Discussed further in Chapter 4, the study's professional development programme takes a 'constructivist' approach. That is, new knowledge and understanding is considered constructed by the teacher, based on what they already know and believe (Piaget, 1952; Vygotsky, 1978). So, although teachers might be involved in the same professional development experience, each person may learn something different.

Shulman (1987) identified seven knowledge bases specific to teachers. These were: content knowledge; general pedagogical knowledge; curriculum knowledge; knowledge of characteristics of the learners; knowledge of educational goals; knowledge of educational contexts; and, pedagogical-content knowledge (PCK). This study's professional development programme focused on the latter two knowledge bases, that is, knowledge of context, which, in Shulman's eyes, includes the 'working of a group or classroom' (1987:8) and PCK which he saw as the:

> blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction. (p.8)

Therefore, for teachers involved in the professional development described in this study, learning was anticipated to occur mainly, but not exclusively, within these two knowledge domains.

Approached from a sociological perspective, learning, Sfard (1998) asserts, is situational, that is, it is interactive and social, based on discourse and a community of practice (Lave and Wenger, 1991; Cobb, 1994). A community of practice is seen as 'a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice' (Lave and Wenger, 1991: 98). Lave and Wenger posit that, within this unique setting, lies the intrinsic conditions for the existence of the knowledge and the necessary interpretive support for sense-making. Hence, whilst focused on the individual teacher, this study acknowledges the importance of context to understanding learning and how professional development is experienced. The role of the context is returned to in Section 2.3.

Following other studies (for example, Bell and Gilbert, 1996) this thesis considers (teacher/ professional) development and (teacher) learning (education) as interchangeable. However this perspective is contested. Hoban (2002), for example, rejects the substitution of 'development' for 'learning' arguing that it conveys a mechanistic linear view of learning. The following two sections explore such different positions.

2.2.1.2 Defining professional development

Section 2.1 identified professional development as having two interlinked premises: professional development as continuous process (unplanned) and professional development as purposeful activity (planned). This confusing duality of meaning is possibly the result of Richard Gardner who, in the 1970's, coined the term Continuing Professional Development (CPD). Gardner, in charge of the professional development of building professionals at York University, felt the term was useful, no longer differentiating between learning from courses and learning 'on the job' as other terms had done in the past (Leaton Gray, 2005).

Following an enquiry into teachers' professional development Leaton Gray proposed,

> CPD embraces the idea that individuals aim for continuous improvement in their professional skills and knowledge, beyond the basic training initially required "on the job''. (2005: 5)

Whilst maintaining the term's duality, the claim that professional development is for the fulfilment of individual professional needs *per se,* is questionable (a discussion returned to below in Section 2.2.1.3). Furthermore, as Day and Sachs (2004) highlight, the teachers' view of 'professionalism' would influence their engagement with professional development. 'Professionalism', both generally as well as in the context of teaching, is a contested term and due to the limitation of space will not be interrogated here (see Maguire *et al.,* (2011) for an extended discussion). However, a number of supplementary terms are identified in the literature including; teacher change (Richardson and Placier, 2001), teachers' professional growth (Clarke and Hollingsworth, 2002) and professional learning (Hoban, 2002).

Critiquing these definitions, a shared commonality can be identified. That is, all conceptualise the process as continuous, rather than an activity to be achieved. For example, Richardson and Placier (2001) define 'teacher change' in terms of learning, development, socialisation, growth, improvement, implementation, cognitive and affective change, and self-study. All, it is argued, except self-study, are continuous processes. Clarke and Hollingsworth (2002) view 'teachers' professional growth' similarly, but elaborate on the idea by attempting to elucidate the complex 'change environment' and the 'continuing process of learning'. Finally, Hoban (2002) views teachers' 'professional learning' within the complex context in which it is situated. He, too, defines professional learning as long-term but acknowledges that its non-linear existence is susceptible to multiple conditions that are interrelated in a system that attempts to manage educational change.

2.2.1.3 Professional development: form and content

In the preceding sections, professional development's duality of meaning has been emphasised. In terms of this study's context, professional development was initially conceptualised as a purposeful activity providing teachers with effective examples that enhance their pedagogical practice. By defining it as such, when considered more broadly, it might be argued that the professional development programme is situated within the teachers' continual development, an observation that underlines the interrelationship between the two definitions. However, accepting this study's professional development as a purposeful activity (that is, planned), literatures concerning forms of professional development and the associated content require consideration (Day and Sachs, 2004).

In terms of form, Kennedy (2005), following an examination of international professional development-related literature, identified nine categories of professional development approach: training; award-bearing; deficit; cascade; standards-based; coaching/mentoring; community of practice; action research; and, transformative. The review proposed an analytical framework presenting the nine categorised approaches across a continuum of increased capacity for professional autonomy. Along the continuum, three broad groups were identified: 'transmissive', 'transitional' and 'transformative' (Kennedy, 2005: 248).

Kennedy (2005) classified training, award-bearing, deficit, and cascade approaches, as having 'transmissive' characteristics. An illustration of the 'transmissive' mode is the compulsory in-service training or INSET days introduced in England and Wales in 1988. These are normally one-off days, the emphasis being on delivery rather than outcome; resulting in a perception by teachers that professional development involves formal training courses (Friedman and Philips, 2004). This method focuses on an observable end product and, it could be argued, supports the technical aspects of the job. Day and Sachs highlight the perceived benefits 'to be the most efficient and cost-effective way to reach the huge population of teachers' (2004:8). However, as Fraser *et al.* assert, it does not support professional autonomy; 'rather, it supports replications and, arguably, compliance' (2007:159). Adey reinforces that point stating, 'there is universal condemnation in the research literature for the one-shot 'INSET day' as a method of bringing about any real change' (2004: 161).

Adey (2004) cites research by Fullan and Stiegelbauer (1991, Chapter 4) who list two years as a minimum for 'real change' to occur, and Joyce and Weil (1986) who consider 30 hours of practice necessary for the development of a new pedagogic skill. More recently, Guskey and Yoon (2009) concur, referring to Yoon *et al.'s* (2007) findings, following a review of 1,343 research studies concerning effective teacher professional development. However, the authors emphasise that although time was found as an enabling element for effective professional development, it needed to be 'well organised, carefully structured, purposefully directed, and focused on content, or pedagogy, or both' (Guskey and Yoon, 2009: 497). Furthermore, they stress that virtually all of the effective professional development research studies acknowledged in Yoon *et al.'s* (2007) review, included a significant amount of time for structured and sustained follow-up after the professional development sessions.

Approaches identified by Kennedy as 'transformative' are noted as being on the opposite end of the professional autonomy continuum to those labelled as 'transmissive'. Examples include action research and transformative approaches, which Kennedy suggests are activities aimed at supporting teachers 'contributing to and shaping education policy and practice' (2005: 248). Fraser *et al.* explain further,

> Transformative professional learning suggests strong links between theory and practice (Sprinthall *et al.*, 1996), internalisation of concepts, reflection, construction and new knowledge and its application in different situations, and an awareness of the professional and political context. (2007:159)

For transformative professional development to take place, approaches need to include opportunities for reflection-in and reflection-on-action (Schön, 1983). In this approach knowledge is considered as situated in classroom performance. Schön (1983) explained that the process of reflection-in-action was an attempt to 'think on one's feet' by using past experiences, consider one's feelings, whilst acknowledging the educational context. The process entailing the development of understanding to inform action in the current situation. Reflection-on-action, is what occurs after the event. Independent of the medium used, spoken or written, the process enables space for exploration of the teaching approaches used and the resulting student responses, potentially offering an opportunity to develop questions and ideas.

Finally 'transitional' approaches lie centrally, between 'transmissive' and 'transformative' professional development. Examples include, standards-based, coaching/mentoring and the development of a community of practice. However, Kennedy (2005) suggests that these final approaches have the capacity to support both transmissive and transformative professional development.

The section above sets out the range, and proposed effectiveness, of professional development approaches. That said Guskey and Yoon postulate that rather than structural features of professional development programmes, the importance of the approach lies in the 'specific content involved, the nature of the work and the context in which it took place' (2009:497). Put another way, professional development requires a theoretical framework. So whilst the evidence above suggests that form is important, effective form without purposeful content is pointless (Fullan and Stiegelbauer, 1991).

There are a number of conceptualisations of teacher learning (Desimone, 2009) including, situated (Borko, 2004), cognitive (Wenger, 1987), sociocultural (Kelly, 2006; Shulman and Shulman, 2004) and social constructivist (Bell and Gilbert, 1996; Adey, 2004). Whichever variant is dominant is found to inform the creation and content of the professional development. Finally it is noteworthy that frequently professional development perspectives are often the same or similar to the theories underpinning the related student materials/activities (Desimone, 2009). Hence, frequently overlooked by professional development providers (Wilson and Berne, 1999), the theory base, comprising conceptual frameworks and theoretical foundations, can reveal the professional development planners' beliefs concerning education (Adey, 2004).

This study considers professional development as a planned *action* aimed at changing the practice of the teacher for the advancement of *their learning,* whilst recognising it as a continual process influenced by and influencing beliefs and teacher efficacy. Directly or indirectly, teacher learning will influence student learning. This study is concerned with transitional/transformative professional development strategies where *actions* are designed to engage the teacher in enactment and reflection. Professional development is viewed as a cognitive process situated in and affected by the social setting. This study's professional development programme was situated in England between 2007-2009. A brief historical and political background of teacher professional development in England follows to provide the context for the study's programme whilst offering an insight into the study participants' experiences of professional development.

2.2.2 Historical context of professional development

To divorce professional development, or teacher education, as it historically has been referred, from more general political education ideologies of the past is difficult if not impossible. To understand changes in teacher education it is important to recognise the ideologies influential in shaping political policies in England over the past fifty years. Furlong and Maynard (1995) list the dominant ideologies prior to the mid-1980s as progressivism (the post-war period), liberalism (1960s) and social reconstruction (1970s). Briefly, these ideologies and their influence on education are outlined below. However, for a more in-depth analysis see Furlong and Maynard (1995: Chapter 1), Helsby (1999: Chapter 10) and, for a related analysis of government policy, Burstow and Maguire (2013).

Progressivism is seen as situating the child as central to education, and adapting pedagogy and curriculum to developing individual needs. Liberalism sees education as more than the child but not determined wholly by the 'needs of society'. Rather 'the purpose of education should be the development of the learner as a rationally autonomous individual' (Furlong and Maynard, 1995:12). The 1970s saw a change in the debate and an ideology promoting social reconstruction emerged which sought to bring equality and justice in society, seeing teachers as the key change agent [a notion, it might be argued, reflected in the Government's current White Paper (see Chapter 1)]. Such values influenced government policies on the structure of educational provision, bringing expansion and later contraction and amalgamations within differing educational areas.

Dale (1989) reports that, prior to the mid-1980s, due to the ideological landscape, teacher education enjoyed 'licensed autonomy'. Autonomy brought some exciting innovations in the field of teacher education which Helsby (1999) comments had expanded significantly in the 1960s and 1970s. However, within this climate, teachers' professional development is described as opportunistic and piecemeal rather than planned or organised (Furlong and Maynard, 1995). Much was reliant on the strength and organisation of the local educational authorities (LEA).

Within science education, many opportunities for development arose in the guise of curriculum development. An example of this phenomenon can be seen in the late 1960s and early 1970s with the Nuffield A-level Curriculum project (see, Waring 1979). Such projects were individualistic; no organised strategy was set down within schools or departments for either personal development or dissemination. From the viewpoint of the innovation, Black (Atkin and Black, 2003) comments that a lack of organised dissemination was problematic, resulting in many of the new ideas remaining only with those teachers involved in the original project. Reflecting further, Black notes that these initial teachers were found to be restricted in practice, bound to the rigid interpretation of materials. Black considers the restricted change and lack of new innovative teacher pedagogy was a result of the programme's top-down methods.

From the mid-1980s the educational landscape changed dramatically, linked to wider social and political movements both nationally and globally (Helsby, 1999; Ball, 1999). A new ideology of New Right thinking took hold, these seeds were sown in Callaghan's Ruskin speech, which saw 'hard and irreducible economic facts' begin to dictate change (DES, 1977: 24). The New Right is a blend of neo-liberalism and neo-conservativism. Neo-liberalism promotes the free market. Neo-conservativism is concerned with traditional authority and national identity (Furlong and Maynard, 1995). From this ideology grew the marketization of education; understood as reforms to strengthen competition and differentiation within the school system. Jones observing the outcomes from marketization as 'major shifts in the management and cultures of schools and the behaviours of large groups of parents and school students' (2003: 115).

Menter observes the blend of New Right's ideologies as 'moral authoritarianism' and 'economic libertarianism' (2009: 221), and notes that a 'curious mix of centralizing and decentralising tendencies' is witnessed through education policy. Examples of centralization can be seen in the introduction of the National Curriculum (DES, 1987), end of key stage curriculum tests (often referred to as "SATs"), the publishing of examination results, the raised profile of external inspections (Ofsted), the particularized regime of target setting, and central to discussions surrounding professional development, the National Strategy programme – returned to below. Simultaneously, decentralisation encouraged schools and education departments to compete by exposure to market forces illustrated through the enforced extension of purchasing power to public contracting authorities and institutions, compulsory competitive tendering, independent fund holding and the introduction of teachers' performance-related pay (Helsby, 1999).

Moreover, the previously considered 'licensed autonomy' of teacher education was replaced by a list of competency standards. Devised originally in 1997 by the Teacher Training Agency (TTA, latterly the Training and Development Agency for Schools (TDA), the Teacher Agency (TA) and currently the National College for Teaching and Leadership (NCTL)) (see, for example, 2007), in conjunction with Ofsted, the standards set out to raise competences of newly-qualified teachers. Hartley (1998) draws parallels between this Initial Teacher Education (ITE) curriculum and the National Curriculum imposed on schools, claiming that both reforms can be seen as relating to the 'new managerialism'. Both curriculums are statutory, thereby centrally establishing the content and values of the subject for the professional. Both are audited, through exams (students) and performance reviews (pre and in-service teachers), hence mirroring New Right values.

How successful these standards have been in achieving their objective is questionable. Manning and Dillon (2010), reviewing research concerning pre-service courses in England, Australia and the USA, posit that due to insufficient time, most pre-service teachers were only exposed 'to a baseline repertoire of essential pedagogic skills' (2010: 16, see also Mulholland and Wallace, 2001; Luft and Cox, 2001). In 2007, competency standards for all teachers in England were introduced (TDA, 2007) which might inadvertently point to the insufficient time available to pre-service teachers to initially develop the required skills. The introduction of standards also reaffirms the values of marketization entrenched in the education policy which can be observed in the methods of audit, personal target setting and financial rewards for competence achievement (Hodkinson and Hodkinson, 2005).

This section, so far, has been mainly concerned with general education ideologies and teacher standards. Policy concerned solely with teacher professional development in England was not realised until 2001 (DfEE, 2001). Prior to this there had been little statutory involvement from government other than the introduction of the five days of compulsory in-service provision in 1987 through the Teachers' Pay and Conditions Act (DES, 1987). The Act aimed to provide a national framework within which professional development would be supported and evaluated. Hence a code of practice for providers was created (DfEE, 2001). Adey (2004) criticises the code's focus on management issues (planning, venue, monitoring, and clarity) rather than the quality of professional development. He goes on to bemoan the obvious omission of any 'reference to the nature of the innovation, or development, to be introduced' continuing,

> It does not seem much to ask for that a government policy on professional development, and its associated code of practice for PD providers, should spell out a requirement that the proposed pedagogical development is actually useful. (Adey, 2004: 183)

Finally, as noted earlier, the last decade saw a 'roll out' of the National Strategies programmes. Described by Earl *et al.* (2003: 11) as 'the most ambitious large-scale educational reform initiative in the world' the Strategies provided 'Frameworks' offering detailed guidance of the teaching methods to be employed, claiming to be established on good teaching practice. In 2002, following the Numeracy and Literacy Strategies, the Science Strategy 'went national'. Leaving aside the content of the Strategies, it is the mode of the professional development that is considered here. Using a classic 'cascade approach' a comprehensive training pack with detailed scripts, PowerPoint presentations and video-clips was provided for the dissemination of content and teaching methods (DfE, 2011). The materials were written by small teams (which Adey (2004) comments were of varying quality). The cascade approach enabled the messages to be relayed from national director to regional directors, local authority (LA) consultants, down to lead teachers and science departments. Limited flexibility in the implementation was allowed. Ofsted reporting,

> that regional training events imparted information rather than developed consultants' skills in helping them to modify materials to bespoke programmes. (2010: 16)

Day and Sachs (2004) and Hodkinson and Hodkinson (2005) have argued that the government's conceptualisation of teacher professional development, outlined above, was based on a 'deficit model'. This model situates learning as a body of knowledge to be accepted and required: facilitated by prescribed competencies, accreditations and anticipated financial rewards (Hodkinson and Hodkinson, 2005). Using Kennedy's (2005) framework this professional development type could be classified as transmission offering limited capacity for professional autonomy. Day and Sachs (2004) and Hodkinson and Hodkinson (2005) concurred that for professional development to become an 'aspirational model' (Sachs and Day, 2004:9), where learning is 'participatory and constructed' (Hodkinson and Hodkinson, 2005:111), education policy creation needs to be viewed more from 'inside the classroom'.

In summary, science teachers who have entered the profession over the past decade know only of an education system formed upon New Right ideologies; which includes all of the teachers who participated in this study's professional development programme. For example, the National Curriculum, ITE competency standards and statutory in-service days have always been present. Many teachers have come through teacher education routes considered 'on-the-job training' (for example, Teach First) rather than college-based education (for example, PGCE), which might lack time and resources for reflexivity. Teachers are in schools where, up until 2010, running parallel with this study's professional development programme, the majority of professional development available was through the National Strategy. Furthermore, the profession is currently situated in a climate of performance-related pay that necessitates teachers being set personal professional targets whilst taking into account whole-school development targets. These examples, whilst outlining the current professional development climate in England, also act to exemplify the 'contradictory components' more broadly offered by New Right ideologies of 'regulation and standardization on one hand and devolution, diversity and individualism on the other' (Gewirtz *et al.,* 2009: 6).

2.2.3 Professional development theoretical models

During their study of a professional development initiative in Scotland, Fraser *et al.* (2007) considered Friedman *et al.'s* (2000) review of the promotional literature of UK professional associations, noting competing professional development claims. Possibly due to shifting political ideologies, claims go from lifelong learning and personal development for the professional, through to the need for public peace-of-mind and professional surveillance both by one's colleagues and by one's employer. It is of no surprise, therefore, that conceptual confusion and conflicts arise when professional development is seemingly driven by multiple needs; the individual's personal needs, the individual's professional needs, the collective needs of the whole profession and, finally, society's needs.

Models offer a method to conceptualise professional development. A model can provide a simplified representation of a complex set of ideas, used to describe and make predictions about the behaviour of the system to which the ideas are relevant (Gilbert *et al.*,1998). In allowing for simplification, features need to be removed and attention is focused at differing meta-levels of the issue. By using models, one is positioning oneself, as Adey asserts, to:

> a belief in at least partial predictability of effects on causal factors which must underpin both experimental and correlational research into effective professional development. (2004: 146)

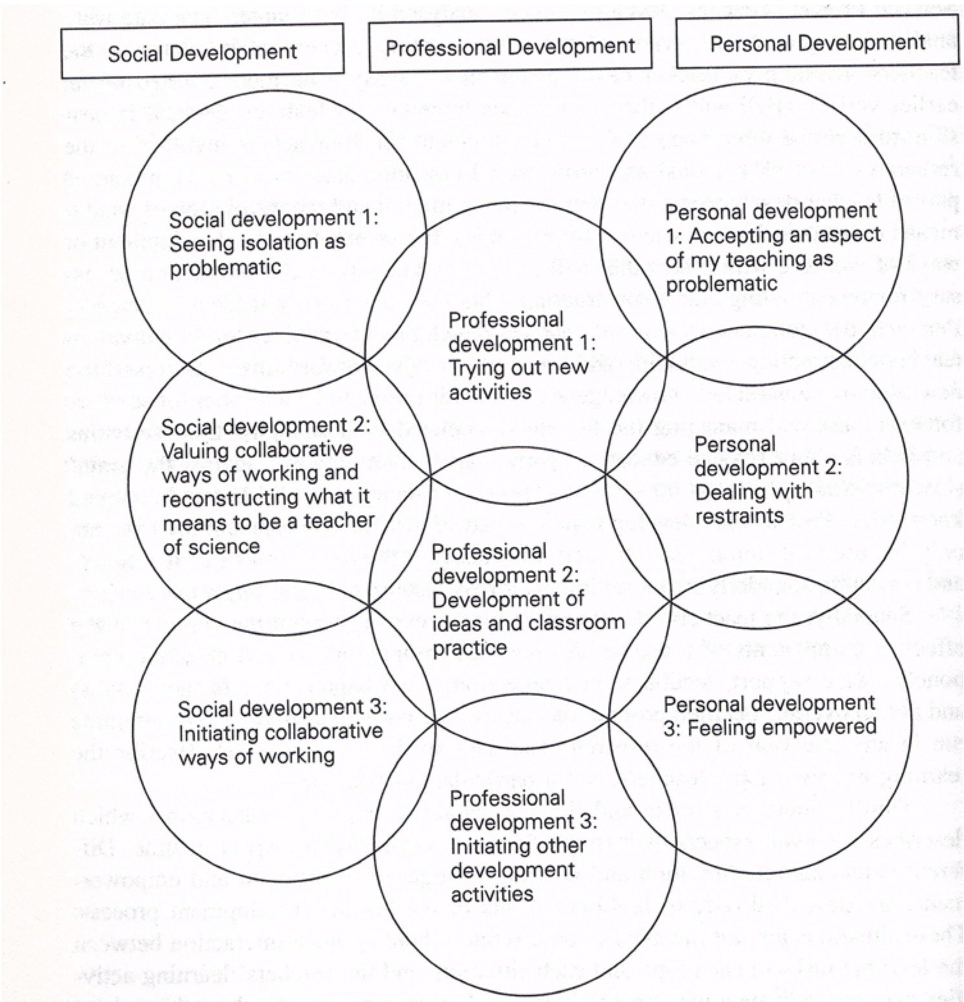
Illustrating the complexity of professional development, multiple models have been developed (for example, Guskey, 1986; Bell and Gilbert, 1994; Shulman and Shulman, 2004; Adey, 2004). Three models – Bell and Gilbert's (1994, 1996), Adey's (2004) and Shulman and Shulman's (2004) – are set out below. Each model explores different perspectives and focuses on particular professional development aspects. As with this study, all the models are the result of extended professional development programmes in which researchers have been involved in data collection (including lesson observations and extended interviews) and, in the case of Bell and Gilbert, and Adey, teaching programme sessions. A shared characteristic of all three models, as well as of this study, was that professional development programmes were all concerned with a social-constructivist pedagogy.

2.2.3.1 Bell and Gilbert's teacher development model

Bell and Gilbert (1994, 1996) analysed the learning of 48 (primary and secondary) New Zealand science teachers involved in a two-year professional development programme, *Learning in Science*. The teachers had a range of experience and responsibilities within the school. Classroom activities were introduced in professional development sessions to trial in school and were reported back on during frequent meetings. Throughout the project, the learning of the teachers was analysed. Based on the findings, the authors developed and proposed a model of the different ways that the teachers engaged in the project (Bell and Gilbert, 1994). The model (see Figure 1) is focused on the individual teacher and identifies three aspects that require development as: personal, social and professional.

Personal development is the construction, evaluation and critical acceptance by a teacher of what it means to be a teacher of science. Part of the development will be the ability to manage feelings associated with change that will occur. Social development is the construction and critical acceptance by a teacher of acceptable ways of working with others, e.g. teachers, students, parents. Professional development is the development of not only the use of different teaching activities but also the development of the beliefs and theoretical conceptions underlying them. (Bell and Gilbert, 1996; Gilbert, 2010)

Figure 1 Bell and Gilbert's teacher development model



(Bell and Gilbert, 1996:16)

As with other models, below, Bell and Gilbert stress that the components or levels presented as isolated are for study purposes only as they are considered inextricably linked. Uniquely the model offers insight into how components change during a professional development programme by presenting three ‘phases’ – initial, second and third. Although not clarified in the model, Bell and Gilbert (1996) assert that drawing the line between personal, social and professional is impossible and movement within the phases is not necessarily unidirectional (teachers may regress due to a change in circumstance).

Bell and Gilbert suggest that for teacher development to be effective the multiple components of the teacher must be addressed but they emphasize the ‘centrality of the social construction of knowledge about teaching’ (1996:14). That is, the role of colleagues, departments and student relationships are instrumental for a teacher’s holistic development. Important to this thesis, the professional component of the model discusses the role of teacher beliefs. However, although confidence and motivation were mentioned, possibly due to the immaturity of the concept when the model was created, teacher efficacy receives limited acknowledgement from Bell and Gilbert.

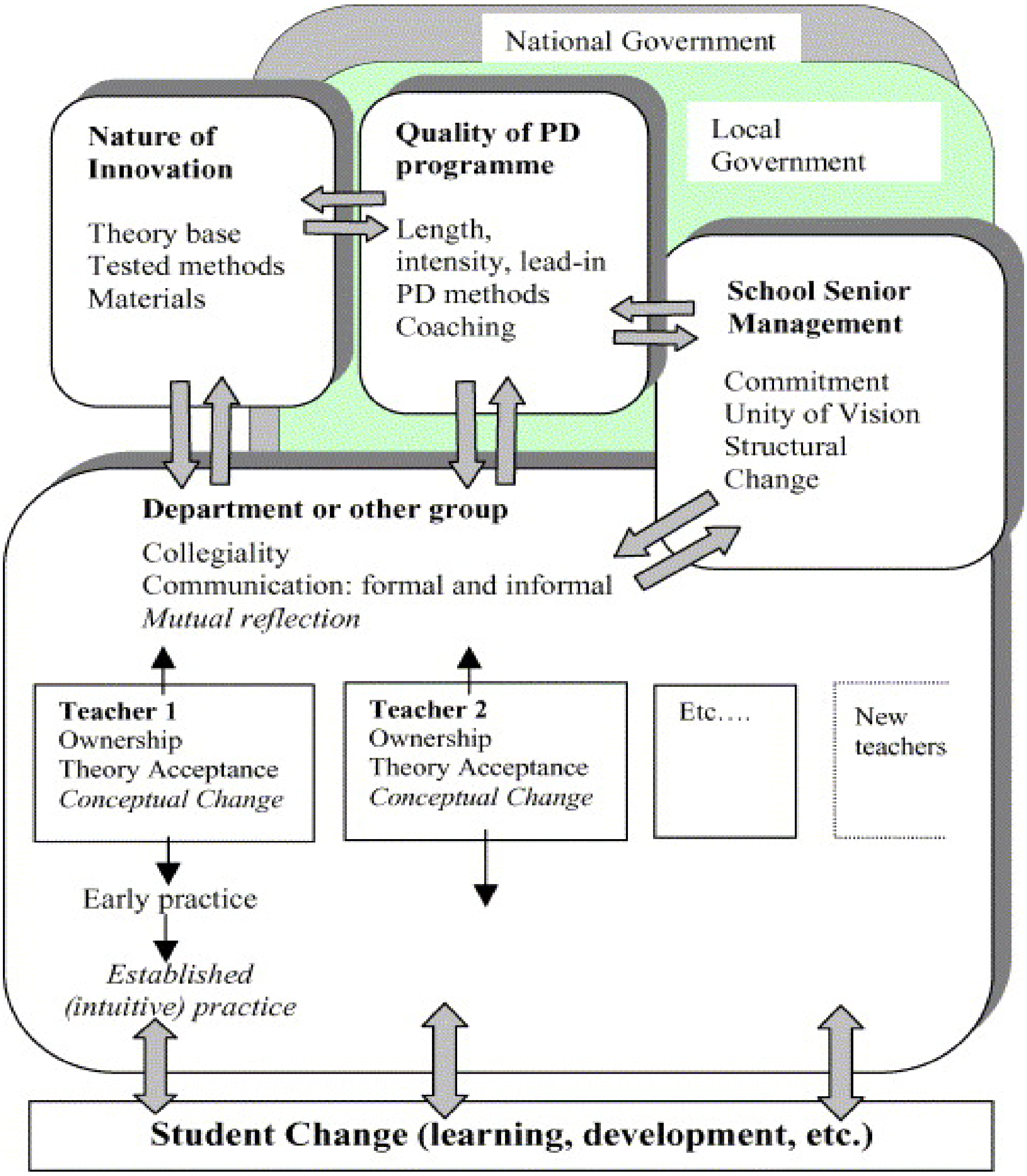
Finally as Fraser *et al.* (2007) and Evans (2002) comment, this model does not take into account the less systematic unplanned, incidental or accidental opportunities for professional development. Gilbert (2010) accepts these criticisms but argues that the model, and the cases from which it arose, are concerned with formal planned professional development opportunities.

2.2.3.2 Adey's model for effective professional development

Adey's model is the result of the author's accumulation from a 'varied body of evidence' over 25 years working in professional development projects (2004:194). Pertinent to this study, and informing his model, was the development of Cognitive Acceleration through Science Education (CASE) activities (see Chapter 4 and Adey *et al.*, 1993, 2001) and professional development programmes. Beginning in England, CASE was a two-year programme introducing thirty activities to secondary teachers to be taught fortnightly alongside the existing science curriculum. The professional development included: multiple sessions over the two years, tutor activity observations/feedback and tutor modelling that included teaching the activities in school.

Adey (2004), from this unique position, provides a model of factors to influence professional development effectiveness (see Figure 2). So whereas Bell and Gilbert's model outlined how a teacher might change due to professional development, this model can be considered as more specific and pragmatic, presenting all the aspects for an effective professional development programme requiring consideration. Whilst all three models highlight the importance of social constructivism to their educational programmes, Adey stresses the importance and the need for programmes to have their own clear theoretical frameworks. Adey lists the model's theoretical frameworks as: conceptual change, established (intuitive) practice and mutual reflection.

Figure 2 Adey's Model of effective professional development



(Adey, 2004:172)

The model highlights three other aspects required as necessary for effective professional development. These are, outcomes (for example, teacher ownership, student change), inputs (for example, the nature of the innovation, the programme quality) and input mediating variables (for example, generative materials and length of programme). As with Bell and Gilbert's model, the importance of the social context is emphasised. In addition to the requirement for departmental collegiality, both informal and formal communication is stressed alongside the role of the school's senior staff commitment. Finally, placed in the background, the model includes the influence from local and national government – although Adey postulates that although useful, they are not essential for effective professional development outcomes.

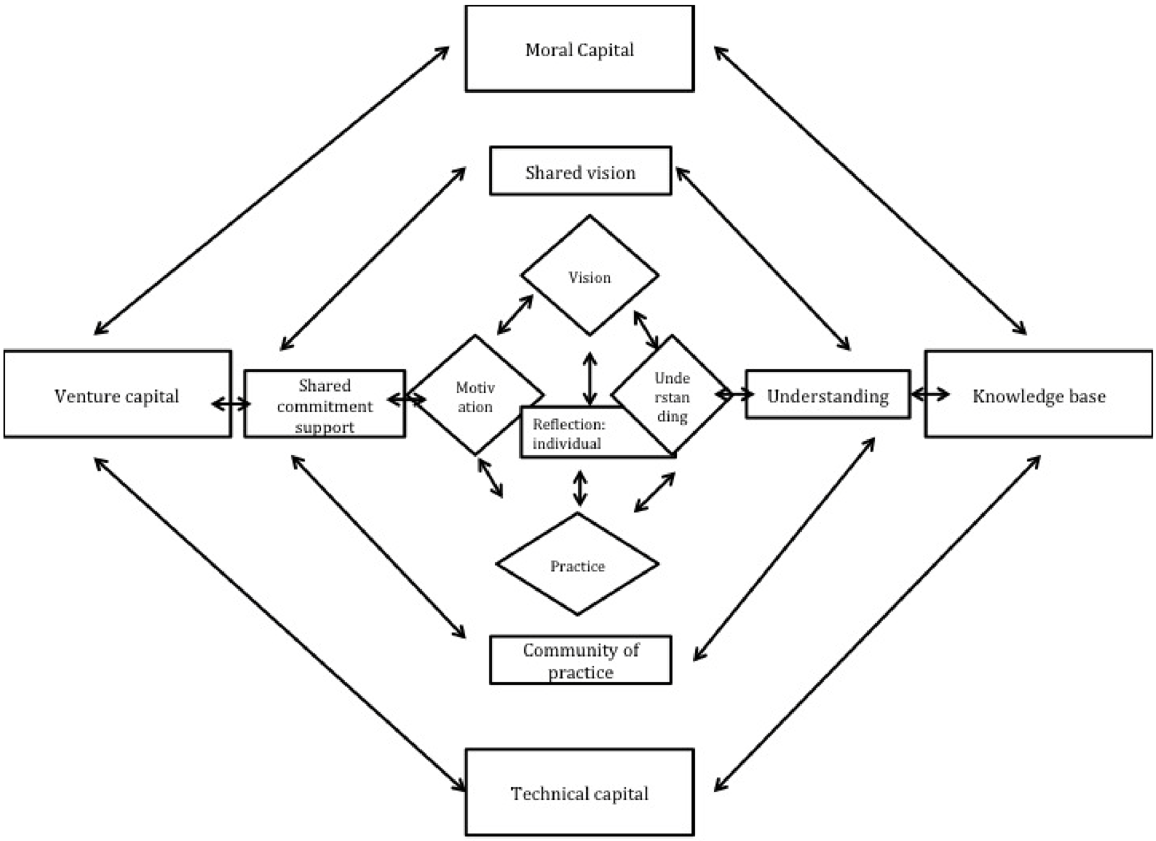
2.2.3.3 Shulman and Shulman's 'community of learners' model

Similar to Adey (2004), Shulman and Shulman's (2004) model was informed by their years of experience of working with teachers on professional development. In particular the researchers had been involved in the US 'Fostering a Community of Learners' programme (see for example, Brown *et al.,* 1993). Through the programme, which involved observing teachers in their classrooms, Shulman and Shulman were prompted to ask why teachers responded differently to professional development. The researchers wanted to create a model for providers so that they could develop teachers able to create, sustain, and educate in a 'community of learners'.

Shulman and Shulman's (2004) 'community of learners' model presents three nested polygons (Figure 3). The reflective teacher is central, surrounded by the domains: individual, community and policy. Unique to the model is the authors' identification of qualities for an accomplished teacher. From these qualities the required features for an effective programme (at the individual domain) are described as: vision, motivation, understanding and practice. Reflective of Bell and Gilbert's classification, the authors' note that each feature 'entails an aspect of personal/professional development' (2004:259).

The second domain, concerning the social contexts, expands the two earlier model's notions of collegiality by building on Lave and Wenger's (1991) 'communities of practice', presenting the teachers as learners and the environment needing to be 'tuned' so that the personal domain might develop. The final domain of Shulman and Shulman's professional development model is policy that is seen to engulf the other levels, possibly indicating the authors' belief in its overall importance for effective professional development – a point returned to in Section 2.3.3.1.

Figure 3 Shulman and Shulman's 'community of learners' model



(Shulman and Shulman, 2004:268)

2.2.4 Summary

This section has attempted to organise and present the complex field of teacher professional development. Definitions, form and content were discussed and the historical background providing a context for this study was presented. The three models together offer an understanding of the complexity of influences on professional development, and, as discussed below, offer three levels of analysis. That is, individual teacher (micro-level), the local community (meso-level) and the wider professional community (macro-level). Due to the study's focus on the individual teacher, particular the role of teacher belief and teacher efficacy, here is a cursory discussion of the micro-level; Chapter 3 considers this level in greater depth.

2.3 Professional development: the influence of contexts

2.3.1 Professional development: the individual teacher (micro-level)

Shulman and Shulman (2004) list attributes of accomplished teachers as: ready, willing, reflective, communal, and able. Adey (2004) identifies teacher attributes required for successful professional development as: ownership, theory acceptance and conceptual change. That is, teachers feeling that the practice belongs to them rather than being imposed on them; teachers' sharing a programmes' theoretical frameworks; and, teachers being open to belief change – particularly concerning the nature of knowledge construction. Guskey (1986) points to a requirement to understand teacher motivation to engage with professional development, whilst Van Eekelen *et al.* place the importance on the teachers 'will to learn' (2006: 408). Whilst all these authors list positive attributes for effective professional development, none suggest how a teacher arrives at these positions. Bell and Gilbert's (1996) model is more helpful, suggesting that the impetus for change originates from the personal dimension of teacher development. They note that teachers arrive at effectiveness with an evolved set of presumptions about the role and a developed ability to manage feelings associated with change. This aspect of their model frames the issues from a psychological standpoint. Chapter 3 discusses these presumptions, or components of the 'belief system', and their influence on pedagogical choice. The section below outlines research that on identifying teacher attributes has categorised teachers' responses to professional development.

Joyce and Showers (2002) developed a professional development framework that focuses on the dynamic between an individual's disposition and their interaction with the environment. In a large-scale longitudinal study of staff development and school improvement practices in California, involving case studies of more than 300 educators from 21 districts in seven counties, they set out to map opportunities for teacher development in schools. The data was collected from three domains: "formal" (courses, workshops and the services of administrators and supervisors), "peer-generated" (professional discussions) and the "personal" (activities in personal lives) domain. By studying teachers' personal lives, an insight was gained into how changes and challenges are reacted to and dealt with. Subsequently, Joyce and Showers (2002) categorised the attitudes and behaviours of teachers presented with staff development programmes. The authors recognised that this approach was crude and, as a result, their categories are represented on a continuum with 10 per cent of individual teachers left unclassified. The categories were:

> *Gourmet Omnivores*: High-activity people who have learned to canvass the environment and successfully exploit it. In the formal domain they keep aware of possibilities for growth, identify high-probability events, and work hard at squeezing them for their growth potential. Gourmet Omnivores constituted 10 per cent of the study group.

Passive Consumers: These teachers display amiable conformity to the environment and have a high degree of dependence on the immediate social context. They are more active when working alongside more enterprising colleagues (for example Gourmet Omnivores). 70 per cent of study group were categorised in this group.

Reticent Consumers: These teachers have developed a reluctance to interact positively with all aspects within the formal domain. They tend to be angry about staff development, deprecate content and avoid follow-up. They expend energy pushing away opportunities for growth. 10 per cent of the study group made up this group.

The Wellcome Trust (2005) commissioned a related study in England to understand teachers' attitudes to professional development. Following a one-off telephone interview, involving 825 primary and secondary teachers and senior school managers, a cluster analysis was designed. The study suggested that teachers could be categorised into four groups based on their professional development attitudes. These groups were:

Believers: Teachers felt that they benefitted from professional development and were enthusiastic that others have access to it. 38 per cent were categorised in this group.

Agnostics: The teacher might agree with the importance of professional development, but doubted its quality or relevance. 33 per cent were categorised in this group.

Seekers: The teachers valued professional development but found opportunities to benefit from it limited. 16 per cent were categorised in this group.

Sceptics: The teacher was dubious about the benefits of professional development, which are seen as focused on government initiatives rather than their own professional needs. 12 per cent were categorised in this group.

From the descriptions it is difficult to distinguish between the characteristics of sceptics and agnostics. It could be argued that sceptics, too, may view professional development as important, if they were not considered driven by government initiatives. Unlike Joyce and Showers' categorisations, where the authors note the difficulty in categorising all study participants and the necessity for groups to be seen on a continuum, the Wellcome report clusters all 825 into the four defined categories, an outcome that is highly questionable.

Both Joyce and Showers' and the Wellcome categorisations can be deemed simplistic and their uncritical adoption may lead to unhelpful stereotyping and misidentification. There is limited discussion in either study surrounding the benefits of grouping individuals. For example, what does such an approach offer professional development providers? That said, Joyce and Showers' categorisation, with its continuum, does serve to stimulate a discussion around the role of an individual's personality, including their beliefs and teacher efficacy, as a contributing factor on the success of a professional development programme. For example, from the study two beliefs identified as influential on teachers' reactions to professional development are: what teachers believe professional development should achieve and what approaches professional development should take. The extent to which the teachers' beliefs are in accordance with those underpinning the professional development programme will influence the teachers' behaviour and their continual involvement.

Guskey (2002) lists three criteria that teachers may use when considering a professional development opportunity. First, will it 'expand their knowledge and skills?'; second will it 'contribute to their growth?', and third will it 'enhance their effectiveness with students?' (Guskey, 2002: 382). Furthermore, Fullan and Miles (1992) report that teachers believe professional development programmes should offer specific, concrete and practical ideas that directly relate to the day-to-day operation of their classrooms. This last point highlights the need for relevance and usability and bridges into the form that teacher professional development *should* take. Hence teachers' beliefs concerning professional development include programme duration and the types of activities that should be included, for example lectures, classroom observations or teacher focus group discussions. Teachers' are concerned with the authenticity of the programme's messages. Sources of authenticity vary from teacher to teacher: some will consider messages based on empirical findings as worthy whilst others will value the more anecdotal experiences of programme tutors and fellow participating teachers (Gilbert, 2010). Hence when a particular activity is not considered as professional development or when professional development messages are not believed to be authentic, rejection is likely. The extent of rejection varies depending on the distance between the teachers' belief and the professional development experienced (Fang, 1996).

Chapter 3 discusses the literature further in an attempt to understand what factors might 'cause' attributes or characteristics – such as beliefs – to emerge within an individual teacher. All three professional development models discussed above highlight the importance of the social/local context on the individual teacher and the effectiveness of programmes. To enable a broader understanding of the factors significant in influencing professional development, the following section explores the contribution of the local context including, students, colleagues and senior staff.

2.3.2 Professional development: the local context (meso-level)

'No man is an island, entire of itself' (John Donne, 1572-1631) is a truism evident in the three professional development models, identified above, which all acknowledge the importance of the social context. Shulman and Shulman (2004) go as far to assert that the importance of teacher development has moved from the individual teacher to the broader context of community. Furthermore, Merton's (1967) observation that people shape their organisations and those organisations, in turn, shape them, highlights the interrelated nature and difficulty in isolating influencing factors.

Looking more widely, what is evident in both Shulman's (1987) and Barnett and Hodson's (2001) teacher knowledge base models that for successful practice to occur, teachers must have the ability to operate in complex classroom/school ecologies. For example, in Shulman's model the apparent importance of social factors to include students and local communities is evident in two knowledge bases: knowledge of characteristics of the learners and knowledge of educational contexts. Similarly in Barnett and Hodson's (2001) teacher knowledge model ('pedagogical context knowledge model') 'classroom knowledge' implies the influence of students. Pertinent to this study, however, is Barnett and Hodson's explanation as to why 'classroom knowledge' is so central to a teacher's success. That is, referring to teachers' 'internal sources', they attempt to explain how external factors interact and have an influence:

> internal sources include reflection on personal experiences of teaching, including feelings about the responses of students, parents, and other teachers to one's actions; external sources include subject matter knowledge, governmental regulation, school policies, and the like. Interaction with other teachers at both formal and informal levels is both a source of pedagogical context knowledge and a stimulus for its further development. (Barnett and Hodson, 2001:436)

Factors identified in the literature concerning the social contexts that may influence teachers' practice and eventual professional development include: students, parents, the local community, department colleagues, heads of department, senior staff and the school-wide ethos. Each of those groups is considered further, below. Finally, Siskin (1994) notes that teachers' responses are bound to their subject discipline. That is, in terms of local context, science teachers' practice, and response to professional development, will be shaped by their physical teaching space (inside and outside the classroom), the availability of resources and equipment, the structure of the school timetable and the time available for planning and reflection - a list by no means exhaustive.

2.3.2.1 Professional development: student, parents and the community

How a teacher develops personally, socially and professionally (Bell and Gilbert, 1994) is intricately linked to their students' social context. Central to teacher development is the goal of increased student learning. No matter what this learning looks like – cognitive, affective social/interpersonal or physical/behavioural (see, Section 1.1.1) – the learning expectation is brokered between students and their teachers (Joyce and Showers, 2002). That is to say, a key aspect driving teachers' professional development is the type and level of learning demanded by both parties. These demands are not only negotiated *between* teacher and students but also *through* students, to differing degrees, by parents and/or carers (NB further references to parents implicitly include carers). Middle class families, for example, with a wealth of cultural and economic capacity, have access to educational knowledge and a greater range of resources compared to working class families (Gewirtz *et al.,* 1995). Thus, this group may raise expectations for learning for their children (in whatever form this may take, for example, higher anticipated class sets, greater grade expectation), inadvertently directing the course of professional development for the teacher. With a change in expectations, the teacher may come to reflect and evaluate classes differently (Reay, 2006). Resulting, for example, in the selection of less risky pedagogical strategies; choosing resources that are more traditional (and thus understood by all 'stakeholders'); and, attending only examination board training.

Johnson *et al.* (2001) extend Barnett and Hodson's (2001) description of internal and external sources in action on classroom ecology and propose an evolutionary perspective of teacher practice. They posit that teachers' knowledge of different pedagogies is 'mutated' through training and instruction. It is the selection pressures from within the classroom that modify the 'mutated' practice, resulting in some behaviours being selectively retained. When the 'habitat' conditions change, a re-selection of strategies occurs. This model illuminates the strong influence found *within* the classroom acting on teacher pedagogical choice. Be that as it may, the model does not take into account the individual's influence on the 'habitat', or what Barnet and Hodson (2001) term the internal sources. The model suggests that pedagogical strategies chosen remain static until conditions change, disregarding the ever-changing dimensions of the individual teacher and their influences on pedagogical choice.

Guskey's (1986, 1989) model offers an explanation of how the relationship between teacher and student impacts on pedagogical choice. Citing work by Lewin (1935), Guskey (2002) posits that changing teachers' beliefs, attitudes and perceptions through direct action is a waste of time and energy. According to Guskey, teachers attempting to change their practice need to observe positive student learning outcomes to trigger, in themselves, a change of beliefs and attitudes. Hence, if a change in practice does not result in increased learning for students then the practice will not be continued. As discussed in Chapter 3, this observation chimes with Bandura's (1997) notion of mastery experiences as a source of teacher efficacy. The interplay between the teacher and student would then appear crucial to the enablement of individual professional change.

2.3.2.2 Professional development: department colleagues

The departmental sphere of influence, which Siskin (1994) terms the 'realm of knowledge', or subject culture, has an influence on science teachers' professional development. The four key parameters affecting departmental cultures, as outlined by Busher and Harris (1999: 308) are, structural organisation (that is, size, subject affiliation and institution location), status or esteem in which the department is held, social cohesion and collegiality and finally, power (in terms of what constitutes power in social situations). To varying degrees, all four parameters will directly or indirectly influence professional development. The initial two, structural organisation and department status, will be considered later, as they are predominately influenced by the senior staff and by the wider school ethos. The latter two parameters, social cohesion and power, are firmly interlinked. Science teachers' colleagues, the head of department and science technicians all wield different types of power within the department, and the form it takes will influence the direction of individual teacher development.

As outlined earlier, Joyce and Showers (2002), in their analysis of teachers' interactions with development programmes, highlighted the significant effect that colleagues within a department can have upon each other. The 70 per cent of professionals categorised as 'Passive Consumers' were said to be very susceptible to the immediate environment and found to be more active when working alongside enterprising colleagues. Joyce and Showers' (2002) findings emphasises the importance of collegiality for the enablement of successful individual development, suggesting the necessity of nurturing relationships so that contexts supportive of risk taking are developed. An aspect echoed in Shulman and Shulman's (2004) 'community of learners' model. It is within such collegial settings that a community of practice is said to develop (Lave and Wenger, 1991).

Approaching the issue from social cognitive theory, Bandura (1997) posits that a group's belief in a common goal is mediated through an individual's sense of collective efficacy. Collective efficacy is defined as:

> a group's shared beliefs in its conjoint capabilities to organise and execute the courses of action required to produce given levels of attainments (Bandura, 1997:477).

It is this collective efficacy, alongside teacher efficacy (discussed in Chapter 3), which Bandura (1997) and Goddard *et al.* (2004) assert, effects how well group members 'can organise and execute the courses of action required to have a positive effect on students' (Bandura, 1997:4). Chapter 3 explores the sources of teacher efficacy. In brief, these are: mastery, vicarious, social experiences and affective states. Goddard *et al.* (2004), through each of these sources, explored how collective efficacy might develop. For example, influential mastery experiences might include past school successes that 'build teachers' beliefs in the capability of the faculty, whereas failures tend to undermine the sense of collective efficacy' (Goddard *et al.,* 2004:5). Whereas an example of a vicarious experience influencing a school's collective efficacy might be the 'replication of successful educational programs across a wide variety of settings by schools aspiring to achieve similar success' (Goddard *et al.,* 2004:5).

Heads of departments/science (HoDs) are middle managers, the layer between senior staff and classroom teachers. They are instrumental in the construction of supportive conditions, collective efficacy, and are increasingly responsible for teacher development (Dillon, 2000; Turner, 1996). That said, senior managers and the wider school ethos, discussed later, heavily influence the role and position of the HoD. To a varying degree, these influencing powers determine whether the HoD is expected to be a leader or a manager of their department (Busher and Harris, 1999). These roles are not exclusive and are difficult to separate, however, depending on which the HoD identifies with, may well in turn influence the departmental approach to teacher development.

Busher and Harris (1999: 306) note, in hierarchical terms, that the HoD as a middle manager is 'responsible for the operational work of others namely classroom teachers', leaving overall strategic development of a school to senior staff. From this perspective, the HoD may have a conformist approach to professional development. They may operate within the restricted boundaries of opportunities offered by government departments, such as the National Strategies, within which, Dillon (2000) observes, lies a model consisting of strategy implementation, review and evaluation followed by anticipated rise in student performance. A HoD holding this restricted view may be more likely to orientate professional development activities, for departmental colleagues, towards narrow examination board run exam skill training.

For HoDs to be seen to wield power as a 'leader' they need to have a vision. This vision is rooted in their ability to translate policies from senior and national levels into classroom practice for and with their staff. Furthermore, their vision for teacher development is one that recognises personal development needs and is able to align these with the demands from the student, department and school. They see development as a progressive long-term individual and shared undertaking. Supported by the three models presented earlier (Section 2.1.3), Busher and Harris cogently articulate: 'An important role for the head of department [...] is to foster collegiality within the group by shaping and establishing a shared vision', adding:

> This style of leadership is people-oriented and requires a leadership approach that helps other people to transform their feelings, attitudes and beliefs. Transformational leaders not only manage structure but they purposefully impact upon the culture in order to change it. (1999:307)

Finally, science teachers' professional development often involves the development of practical skills, for example, the use of new chemicals, apparatus or computer software. Thus, even with extensive external training, for this element to be successful in influencing students' learning, it relies on the support, expertise and willingness of departmental technicians. Echoing Joyce and Showers' (2002) previously presented argument that enterprising teaching colleagues are fundamental to widespread professional development success, the same may be said for science technicians. It is, therefore, suggested that for a teacher to take risks and attempt something new, the process necessitates technicians' knowledge, support and enthusiasm. Technicians beholding of these qualities also offer an opportunity for the science teacher to have someone to reflect and evaluate with, providing opportunities, for example, which may be facilitated though joint teacher/technician training (Jarvis *et al.*, 2008). The importance, therefore, of social engagement is clear. Adey (2004), going further, proposed that: 'No one individual, however well motivated and energised can maintain a new method of teaching if she or he feels isolated' (Adey, 2004:166).

Aside from the necessary collegial support, Adey (2004) affirms that an environment in which change is engendered does so due to the senior staffs' 'sense of ownership' and relatively stable staff attrition. It is in terms of the parameters of structural organisation and department status, two of the four parameters affecting departmental cultures outlined by Busher and Harris (1999:308), that senior staff can have greatest influence. A discussion follows on how these aspects, including the wider school ethos, influence professional development.

2.3.2.3 Professional development: senior staff/school ethos

A school's senior staff may comprise the headteacher, deputies, assistant heads and senior teachers. The school's underpinning philosophy/ethos will determine the senior staff's collective distribution along the leadership/management continuum, the differences between these perspectives being briefly discussed above (Section 2.2.2.2). This positioning will influence the perspective, framework and eventual distribution of teachers' development.

Eraut (1995) argued that the professional development of teachers cannot be separated from the development of schools as professional institutions that create, monitor and review educational programmes and policies. Adey (2004), in parallel to his own findings, cites the studies of Joyce *et al.* (1999) and the conclusions of Fullan (1991) and Mortimore *et al.* (1988) to support his argument that for an educational innovation to be implemented effective school leadership is required. Adey (2004) lists two key reasons for their centrality. First, the recognition of the time required for in-school development and second, the senior staff's capacity for building the innovation into the structure of the school, or at the very least into the department.

Coolahan (2002), in presenting the characteristics associated with successful in-service provision, also suggests that teacher development is often best promoted within the context of school development. However, she argues that, rather than a top-down approach (senior staff onto the department onto the individual teacher), it is best supported and enabled by a 'bottom across' approach. Coolahan is referring to the OECD (1999) description of 'bottom-across' as a situation in which teachers in clusters of schools collaborate on professional learning and development activities.

Hargreaves' (1994b) professional development model, referred to by Day and Sachs (2004: 10) as 'post-technocratic', similarly echoes Adey's (2004) ideas, suggesting that for successful professional development to occur opportunities must be contained in school development plans. Be that as it may, Hargreaves postulates that the individual needs of the teacher must be reconciled within the school plans for successful outcomes to be achieved. Day and Sachs (2004) distinguish the needs of the teacher and those of the whole school for professional development, as a symbiotic relationship, but see achieving a balance as fraught. The difficulty is in part due to the wide-ranging needs of the teacher, and constitutes complex relationships between compounding factors. The tensions are also partly due to the school's underpinning philosophy/ethos. Finnan and Levin describe the school culture as being:

> moulded by the unique and shared experience of participants, which are influenced by their class, race and neighbourhood as well as their school's history and leadership. (2000: 89-90)

Even in situations where the school culture is suitable in heralding a successful symbiotic professional development relationship between teacher and school, the present instability within schools due to high teacher attrition rates and staff shortages, frequently makes such a model untenable (Smithers and Robinson, 2001).

A number of researchers have tried to classify the 'ideal type' of school culture, or ethos, which encourages professional development. Day and Sachs report that all attempts have resulted in failure due 'to its unique and non-static nature' (2004:10). Notwithstanding, Busher and Harris, in their review of research findings from diverse countries and school contexts concerning school improvement and school effectiveness, assert that:

> Schools that are effective and have the capacity to improve are led by headteachers who make a significant and measurable contribution to the effectiveness of their staff.

(1999: 306)

Returning to the discussion of what form this influence takes, whether it is leadership or management, Smyth *et al.* (2000) note a wider cultural shift in education towards managerial professionalism. They argue that this shift has come from a change in the aims of schooling to one that promotes increased economic prosperity (resulting from New Right ideologies (discussed in Section 2.1.2)), ignoring, to a greater or lesser extent, any other forms of capital gains (for example cultural capital). This marketisation of education, explored below, heavily influences the decisions made by headteachers relating to teacher development (Shulman and Shulman, 2004).

Viewed at a meso-level, the literature reviewed above reflects the dynamic and convoluted positioning of teachers' professional development in relation to the numerous 'stakeholders' including; students, colleagues and senior staff teams. The following section considers the influence of the wider professional community and 'other sectors', positioned at the macro-level of analysis. This final section considers how these groups directly and indirectly, and visibly and invisibly, influence science teacher professional development.

2.3.3 Professional development: the wider professional community (macro-level)

2.3.3.1 Professional development: the government

Evident in the historical context for teacher education and professional development in England (Section 2.2.2) is the power welded by numerous groups that could be described as peripheral to the day-to-day experience of teachers and schools. Adey (2004) asserts that although it is common for teachers to display an ignorance of the interrelationship between school and government policies separating the local context from the ties of the wider political framework is naïve. Similarly, Nuthall (2005), following a career of working alongside teachers in research projects, concurs with Cuban (1998) in postulating that one of the main obstacles to transforming classroom teaching is teachers' unwitting unawareness of how government policy impacts their practice.

The influence on professional development from sectors outside the school is evident in Adey's (Figure 2) and Shulman and Shulman's (Figure 3) models. Both highlight the role that 'government' has on teachers' professional development. Perhaps as a result of the authors' different 'national' experiences (Adey's being mainly English and Shulman and Shulman exclusively US), different interpretations of influence from government are identified.

Adey's (2004) model situates local and national government behind 'local conditions'. He postulates that whilst they are useful, in that they 'provide funding and create an environment conducive to change' (p.173), they are not essential. That is to say, for effective professional development outcomes, whilst all the other aspects of the model – for example, the nature of the innovation – are required to operate positively, local or national government support is considered useful but not vital, that is effective professional development can result without it. That said, Adey illustrates how governments have been instrumental through policies to create 'environments conducive to change' (2004:173). For example, policies such as the DfEE (2001) professional development policy, Adey acknowledges, not only brought funding benefits, but more importantly, raised the profile of teachers' professional needs. As Hargreaves (1994a) notes, such explicit policies enable long-term commitment, as opposed to episodic and unsustained endeavours. The literature, however, acknowledges that national teacher professional development policies can result in negative, rather than positive, outcomes on teaching and learning (Hodkinson and Hodkinson, 2005). It was acknowledged in Section 2.2.2 that government ideologies help to shape education reforms and the teacher profession. For example, whilst editing the *International Handbook on the Continuing Professional Development of Teachers,* Day and Sachs observed '[a] recent shift from locally designed and locally controlled reform initiatives to centrally defined imperatives linked to standard-based accountability' (2004:8). The result in England of this move to centrally defined imperatives, it could be argued, is that 'New Right' policy changes have resulted in teacher development being seen as a commodity to be acquired. This culture, where learning is seen to be instrumental, is supported through ubiquitous forms of audits, personal development targets and competence standards, a situation that returns us to the earlier discussion of how professional development is conceptualised. So, although Adey's model acknowledges the influence of local government, it might be considered largely historic, as the power has shifted directly to headteachers.

Turning to Shulman and Shulman's (2004) model, rather than the government's influence being in the background, as Adey saw it, government policy is perceived as being on the outer polygon – surrounding and dominating the other factors. In contrast to Adey's position, Shulman and Shulman consider 'the policy world [as] both the sustainer and the executioner of the innovations in teaching and learning' (2004: 267).

The importance of policy is further explored by Shulman and Shulman through four 'capitals' – *knowledge, curricula, venture and technical*. Here Bourdieu's conceptualisation of 'capital' that centres much of his theoretical analysis on social class inequalities (for example, Bourdieu, 1986a) is brought to mind. Although Shulman and Shulman do not cite Bourdieu, they do acknowledge the use of the metaphor 'capital' as defining a resource. This usage resonates with Bourdieu's (1986b) reference to 'capital' as the set of useable resources and powers available to each individual within the field.

Bourdieu's 'capital' can be separated into three domains: *social, cultural and economic*. Shulman and Shulman focus solely on the economic domain. Economic, or *venture capital* (provisional of financial incentive), is said to supply, *curricular capital*, *cultural or moral capital* and *technical capital*. The authors do not elaborate in their paper on those three forms of capitals. Shulman and Shulman's model, in viewing government and policy impacts upon education as solely economic, ignores the power of the government 'stakeholder' on cultural and social domains. Such influences on these capitals – or ideologies – are evident in curriculum specification, teaching and learning, as well as school inspections, as previously discussed (Section 2.1.2). The model, in calling attention to finance as one of the central tenets in the pursuit of successful teacher development programmes, differs from Adey's. Shulman and Shulman see the finances as essential for adequate resourcing to include, 'mentoring, staff development, curriculum and assessment materials, instruments and models of assessment, additional personnel, computers, physical space for groups and rotation, *etc*.' (2004: 267)

In light of the discussion above, this study's professional development programme – 'Thinking Beyond the Classroom' – might initially be considered free from government influence as it was not funded or designed by government agencies. On further reflection, government influence is evident, for example, as the activities were designed to take account of the National Curriculum. As to finance, although I am in agreement with Adey that monies do not ensure effective professional development programmes, creating the 'conducive environment' would have been difficult, if not impossible, without financial support from the AstraZeneca Science Teaching Trust. Hence, the Chapter's penultimate section considers how 'other sectors' within the wider professional community wield influence over teacher development.

2.3.3.2 Professional development: 'other sectors'

'Other sectors' within the wider professional community include: universities, charities, non-governmental organisations (NGOs), private companies and learned societies. Their influence on teachers' professional development may be direct, for example, through providing training, research-informed practice and funding. Or indirectly, for example, through government lobbying, proposing and regulating teaching standards and interpretation of curriculum for assessment purposes. None of the three models, set out in Section 2.1.3, attend explicitly to this factor and related research is limited. Two examples of 'other sector' involved in this study's professional development programme are explored below to exemplify the influence they may yield: the AstraZeneca Science Teaching Trust (AZSTT) (becoming the Science Teaching Trust in June 2013) and the university (King's College London).

The AstraZeneca Science Teaching Trust funded the study's two-year professional development programme. Their website states that their philosophy is to improve science teaching through supporting teacher development (www.pstt.org.uk). The direct influence they have had on teacher development results from the financial support provided for over 100 programmes since 1997 (*ibid.*). However, absent from the website are reasons as to why the 100+ programmes were chosen. That is, what theoretical bases informed the judgement of the proposal? This question can be asked of similar funding bodies of science education professional development including: the Gatsby Foundation and The Wellcome Trust. All funding organisations have a belief/vision of what science education should be – beliefs influencing professional development provision.

University staff, informed by their research findings can have a direct influence on professional development design, implementation and evaluation. For example, in this study, King's had a central role in the programme's development and teaching, having successfully bid for funding from the AZSTT. Tutors' interpreted their own and colleagues' research concerning Assessment for Learning (AfL), CASE and professional development into practice. However more often, university staff are consulted by 'providers' developing programmes, such as the Science Learning Centres or other bodies (for example, the National Strategy team as discussed in Section 2.2.2). This relationship has been noted to have positive effects. Guskey and Yoon, citing Yoon *et al.'s* (2007) review of effective professional development programmes, postulate effective programmes are those which are,

> focused principally on ideas gained through the involvement of outside experts […] either programme authors or researchers who presented ideas directly to teachers and then helped facilitate implementation (2009:496).

The influence and importance that government and external bodies together have on teachers cannot be under-estimated. However, written policies, research findings and programme proposals are only as good as the practice they induce. Day and Sachs (2004), mindful of this limitation, return to the importance of the teacher when they warn policy-makers never to lose sight of the 'skill, knowledge and sheer emotional energy which teachers need in order to engage in intelligent planning and action in the classroom as agents of change' (2004:11).

2.3.4 Summary

This section presented the range of contextual influences on teachers' professional development. The literature presents a complex picture consisting of multiple and interlinked 'stakeholders'. These have been explored at three levels: micro, meso and macro. The examination provides an understanding of the significant factors that might influence teachers participating in this study's professional development programme. Of particular significance, aside from the role of the individual teacher (discussed further in Chapter 3), was the role that social context had on professional development outcomes.

2.4 Chapter summary

Teachers' professional development is an ambiguous and contested concept. The political ideological landscape has changed dramatically over the past 50 years from progressivism to New Right thinking. This ideological shift towards neo-liberalism and neo-conservatism has impacted on teacher education through forces of marketization, regulation and standardization. It is within this present political context that this study is situated, and it is from that context that the study's conceptualisation of professional development has arisen.

For the purpose of this thesis, professional development practice is conceptualised as a planned *action* aimed at changing the practice of the teacher for the advancement of *their* *learning.* Directly or indirectly, teacher learning will influence the learning of their students. That said, as learning is understood as socially constructed, the professional development practice is situated in teachers' wider experiences and understandings. Professional development takes multiple forms concerning different contents. What emerged from the literature was the potential effectiveness of professional development strategies categorised as transitional/transformative in contrast to transmissive. Furthermore, it emerged that effective teacher development required explicit theoretical theories, or at the very least, a clear outlined purpose. Using the literature and the notions of form and content, Chapter 4 presents an analysis of the study's professional development programme.

Professional development as an activity does not take place in isolation. Theoretical models, considering professional development from various perspectives, suggest that teacher learning is driven and influenced by multiple 'stakeholders'. The 'stakeholders' can be analysed at three levels: the individual professional (micro-level), the students, parents and staff within the local context (meso-level), and wider professional aspects (macro-level). With learning seen as being socially constructed, it was natural that more effective teacher development was identified as more likely to develop in positive social contexts: departments and whole schools.

The literature discussed in this chapter supports the purpose of this study which is to identify professional development factors influencing teachers' practice. However, understanding why teachers respond to particular programme strategies – particularly related to teaching outdoors – or why particular conditions are influential on some teachers but not others has only briefly been addressed. All three professional development models – Adey's (Figure 2), Shulman and Shulman's (Figure 3) and Bell and Gilbert's (Figure 1) – acknowledge the role of the individual teacher in teacher development. However, in general, effective teacher traits or characteristics are listed, which, for the purpose of this study, were considered superficial. That said, Bell and Gilbert's model, from the perspective of teacher change, does consider teachers' beliefs – but not teacher efficacy – and as these two concepts are found to influence teachers' pedagogical choice to teach outside, they require further exploration. Chapter 3 explores teacher beliefs and teacher efficacy, their influence on teacher choice, how they are measured and how and why they change.

Chapter 3 Teacher Beliefs and Teacher Efficacy

3.1 Introduction

This study's aim was to explore the relationship between science teachers' beliefs, teacher efficacy and pedagogical practice during a two-year professional development programme focused on outdoor learning. The focus on the individual teacher, that is, at the micro-level, was established in response to the need to understand why some science teachers were able to circumvent barriers to teaching outside whilst others were not. Chapter 2 set out three models of teacher development which offer shared, as well as diverging, perspectives. Bell and Gilbert's model provided the greatest focus on the individual teacher as the agent for change. The authors assert, for example, that for pedagogical change to take place, teachers needed to accept an aspect of their teaching as problematic. Bell and Gilbert's model, however, did not offer an understanding of the process through which a teacher identifies a problem, or how the change process might best be promoted; a depth of knowledge that this study required.

To that end, this chapter explores the research literature concerning teacher beliefs and teacher efficacy in an attempt to establish how they are conceptualised, their relationship with pedagogical practice and professional development implementation, and how they may be measured. Beliefs and teacher efficacy are situated in a complex psychological landscape – the belief system. The following section provides a brief overview of the belief system and how it is formed.

3.2 Belief system

Richardson and Placier (2001), following a review of the teacher development research, suggest that in the majority of teacher change studies, teachers are assumed to have autonomy and choice. However, Cochran-Smith and Fries (2005) argue that teacher choice is limited not only by external factors, for example school rules, regulations and policies (meso and macro-level factors), but by an internal processing system. This internal processing system has been conceptualised as consisting of a belief system (Clark and Peterson, 1986; Jaccard *et al.,* 1999; Jones and Carter, 2007). Beliefs and teacher efficacy are thought to reside in the belief system alongside other components including: attitudes, motivation, expectation, epistemologies and identity (Jones and Carter, 2007). The components are considered intertwined, having much conceptual overlap (Pajares, 1992). Borko *et al.* (1981) and Pajares (1992) assert that the belief system components combine to affect the interpretation of external stimuli (for example a professional development programme), influencing the resulting pedagogical decisions and practice outcome. Nisbett and Ross (1980) and Shavelson (1983) have likened the belief system to a filter through which a host of judgements and decisions are made.

Components of the belief system are influenced by biography and experience (Richardson and Placier, 2001). For example, Butt and colleagues (1992), in developing several teacher case studies following a professional development innovation, concluded that various forms of previous experience affected the direction of evolution of teachers' pedagogical practice. The influences were wide-ranging and included: experiences as children, peers, parents, and as teachers, experiences within particular cultural settings, and personal professional experiences. Bullough and Baughman, in an eight-year longitudinal biographical teacher study, which categorised life experiences into 'professional' and 'private' life, found that,

> no specific event or factor produced the change [in practice], although evolving life circumstances and altered work conditions played important parts. (1997: 95)

They recommended,

> [...] that selves and professional identity change is certain, but teachers' identity needs to be understood in relationship to living life and forming and seeking to maintain a self within shifting contexts. (*ibid.*: 95)

Hence, although past and present experiences are important, as they eventually affect pedagogical decisions, it is the deeper concepts of the belief system that were considered pivotal. Past experiences/biography inform the belief system and the later decisions they influence. However, perhaps the reverse might also be true – that is, the belief system informs how past experiences/biography are understood.

Teachers make multiple decisions when planning and teaching lessons. This study is concerned with teacher decisions that include: how to use the outdoor space, what activity/equipment to chose, how to structure group work and the types of questions to ask. As noted earlier, the decision outcomes will, in due course, become a past experience, eventually informing the belief system. Although this study is principally focused on teachers' pedagogical decisions, the belief system influences all decisions including interactions with pupils, parents and colleagues (Pajares, 1992).

Decision theorists have distinguished three types of decisions: *routine, impulsive and thoughtful* (Jaccard *et al.,* 1999). As the names suggest *routine* decisions are those made routinely with little consideration; *impulsive* decisions are characterised by limited thought about the different decision options; and, *thoughtful* decisions are those where consideration is given to the potential outcome of an action. This study, concerned with planned and unplanned actions considers both *thoughtful and impulsive* decisions. However, whilst teacher beliefs and teacher efficacy are often considered to be reflected in pedagogical decisions – articulated and observed – it is accepted that this is not always the case. Components of the belief system may be hidden – a pedagogical decision might not mirror the belief held by a teacher - perhaps due to influences from the meso-levels and macro-levels (see Chapter 2). Verbalised beliefs might be in conflict with behaviour (Mansour, 2009).

3.3 Teacher beliefs

Beliefs play an important role in how and why teachers engage in particular teaching practices (Borko and Putnam, 1996; Richardson, 1996). Beliefs have been identified as enabling people to maintain, insofar as possible, a sense of self and,

> [a] group identity, stable and continuous over time – an identity that is a part of and simultaneously apart from, a stable physical and social environment. (Rokeach, 1968: 11)

Gregoire (2003) argues that without understanding how teachers' beliefs relate to their practice or to student outcomes, the gap between education reform and teacher implementation will persist.

Section 2.2.1 outlined research categorising individual teacher reactions to teaching and professional development opportunities (for example, Joyce and Showers (2002) and Wellcome (2005)). This section, following an exploration of the term belief, builds on Section 2.2.1 to discuss research specific to science teachers' beliefs identified as influential on pedagogical practice or reactions to professional development. Beliefs, relevant to this study, identified in the literature include: learning and teaching science, the epistemology of science, and outdoor teaching (related to, practical work, environmental education and managing student learning). Section 3.5 discusses research methods used to 'capture' teacher beliefs.

3.3.1 Conceptualising beliefs

Pajares describes the notion of 'beliefs' as 'messy', and highlights the contestation of terms in the research literature:

> [Beliefs] travel(s) in disguise and often under alias - attitudes, values, judgements, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, personal theories, internal mental processes, action strategies, rules of practice, practical principles, perspectives, repertories of understanding, and social strategy, to name but a few that can be found in the literature. (Pajares, 1992: 309)

Among the multiple definitions, there is some agreement that beliefs are seen as a process of valuation of an item, taking place in one's mind. For example, Luft *et al.* define a belief as 'personal constructs', that is 'propositions considered to be true by the individual … non-evidential as they are based on personal judgement and evaluation' (2003: 1-2). Similarly, Loucks-Horsely *et al.* propose that, 'beliefs are more than opinions: they may be less than ideal truth, but we are committed to them' (1998: 27). However, there is less agreement about the similarities and differences between beliefs and knowledge. For example, Tobin *et al.* (1994) define beliefs as a form of knowledge that enables people to meet their goals whereas Pajares (1992) cautions that a distinction between belief and knowledge is necessary. Pajares explains that knowledge is based on objective fact, while beliefs are based on evaluation and judgement. Richardson (1996) states, simply, that beliefs are different from knowledge because they do not need to be true. However, Mansour (2009), referring to research by Nespor (1987) and Kagan (1992), sides with Tobin *et al.*, seeing beliefs as a form of knowledge. Mansour argues that 'most of a teacher's professional knowledge can be regarded more accurately as beliefs' (2009: 27), adding:

> According to Kagan, as a teacher's experience in classrooms grows, this knowledge grows richer and more coherent and thus forms a highly personalized pedagogy or belief system that actually controls the teacher's perception, judgment, and behaviour. (*ibid.*)

Perhaps the degree to which teacher beliefs and professional knowledge are seen as similar might depend on the extent to which beliefs are considered as 'relatively stable and resistant to change' (Kagan, 1992:66). Woolfolk Hoy *et al.* (2006) conceptualise teachers' beliefs as products of their experiences as students which then act as screens through which new teaching approaches are interpreted. Viewed from this rather static perspective, what influence (if any at all) can teacher professional development hope to have? Whilst I accept that teachers' biographies prior to entering the profession are important to the development of teacher beliefs, it would seem reasonable to expect those beliefs to change over time in response to a changing environment (see, Rokeach, 1968:11). If this was not the case, and no belief change occurred, then feelings of acute dissatisfaction might be manifested. Planned and unplanned professional development is therefore considered as significant in facilitating teachers' belief change.

Teachers hold a range of beliefs related to their profession and their subject specialism. Rokeach (1968) and Ajzen (1988) conjecture that beliefs can be ordered along a central peripheral dimension determined by their intensity of connectedness. They considered that more central beliefs – core beliefs – are formed very early in life and involve the nature of oneself and one's physical and social world. This belief type is thought to be static and very difficult to alter. If they do undergo change, the impact may be felt across a substantial number of other beliefs. Rokeach (1968) postulated that beliefs which are more peripheral to one's core beliefs are shaped by accumulation, education and schooling; the further a belief is from the core, the more open it is to influence. Furthermore, the closer a belief is to the core, the greater potential it has to impact centrally-held beliefs. So, for example, a teacher might hold a core belief concerning how children learn and a peripheral belief concerning how they should be taught. The belief concerning how children learn will be more static than the more peripheral belief. The proximity, metaphorically speaking, of the two beliefs to one another will determine the extent of influence they have on each other.

Emerging from the earlier discussions in this chapter is a view that the idea of a simple unidirectional relationship between beliefs and pedagogical decisions neglects the influential role that decision outcomes have on beliefs. As Bandura (1997) explained through his theory of self-efficacy (see Section 3.4.1), if a conscious action did not reflect a teacher's belief, but resulted in a positive outcome, and if the actions were maintained and positive feedback continued, the long-term consequence might be a change in beliefs. Guskey (1986) reports a similar relationship, finding that professional development programmes were usually unsuccessful in bringing about a change in beliefs unless teachers could be convinced to trial procedures which then resulted in improvements in student achievement. He proposes that belief change did not materialize itself in teachers who did not use the techniques, or who were unable to observe student improvement. Guskey (1986) postulates that belief change follows, rather than precedes, changes in behaviour, which is another example of a unidirectional relationship, this time, however, in the opposite direction. I suggest a bi-directional model, that is, beliefs shape pedagogical decisions and pedagogical decision outcomes shape beliefs. Changes in beliefs may, however, be temporary. A change in context or an end to positive student feedback might halt the process of pedagogical change and return beliefs to their original state (Mischel and Shoda, 1995). Furthermore the process might be affected by the belief's position – whether it is core or peripheral to the wider belief system (Rokeach, 1968).

3.3.2 Teachers' beliefs: learning and teaching science

Bell and Gilbert (1996) asserted that teachers' beliefs concerning how children learn were important to the successful outcome of a professional development programme. They proposed that success related to the degree to which teachers' beliefs aligned with those informing the professional development programme framework. Chapter 4 discusses the pedagogical framework on which this study's programme was developed. Put briefly this study's programme, like those studied by Bell and Gilbert (1996) and Adey (2004), rested on a social constructivist perspective – where affiliated pedagogical practice includes group work and student collaboration.

Not all teachers view teaching and learning from a social constructivist perspective. Following a review of literature on teachers' beliefs about teaching and learning, Calderhead (1996) identified two emerging views of teaching as: knowledge transition and guiding learning, whereby a social constructivist perspective might be aligned with the latter. This categorisation of teacher beliefs might be considered rooted in a wider debate concerning theories of learning – the behaviourist/cognitivist dichotomy. Whilst each theory is set out below, I accept the dichotomy as simple and potentially misleading. That is, rather than polarised, I consider teachers' beliefs operate on a continuum between the theories, the sections below offering very contrasting perspectives.

3.3.2.1 Behaviourist/cognitivist dichotomy

Although there are many approaches subsumed under the term behaviourism, the commonality between them is that behaviours can be described scientifically without recourse to internal physiological events or to hypothetical constructs such as the mind (Hayes, 2002). In passing, it is worth noting that the inclusion of notions such as 'beliefs' and 'teacher efficacy', which are constructs of the mind, suggests that this study is positioned outside such a theoretical frame.

At the extreme end of the behaviourist approach are those who consider people as blank slates on entering the world with learning taking place through either classical or operant conditioning. Classical conditioning (Pavlov, 1927) is the process through which a reflex response becomes associated with a stimulus that would not naturally activate the behaviour. Operant conditioning (Skinner, 1974) is the process of conditioning voluntary behaviour through reinforcement and punishment. What both processes have in common is the stimulus-response model, whereby there is no presence of a mediator, for example the mind.

In very general terms, if a science teacher were to hold a behaviourist view of learning, research proposes a number of associated features that might dominate their teaching (for example, Richardson, 1997). Teachers would view themselves as the authority (in terms of their subject) and students would be seen as vessels into which knowledge could be poured, evoking extensive didactic teaching styles, for example, lecturing (including, perhaps, a large number of PowerPoint slides), closed – one word response – questioning techniques, and a high frequency of initiate-response-evaluate forms of teacher-student talk. Teachers might also be seen to advocate *programmed instruction* – whereby the student reviews information, answers questions about it, and proceeds to a more advanced task if correct. Skinner, himself, supported this form of mechanistic teaching (Hayes, 2002). Finally teachers believing learning occurs through operant conditioning might be seen to rely heavily on systems of rewards and sanctions as their main method to control student behaviour.

In contrast to behaviourist theories, cognitivist theory places value on the internal workings of the mind (Hayes, 2002). Many theories of learning concerning the mind have been developed. Relevant to this study, and perhaps the most frequently cited in education are stage theory, constructivism and social constructivism. Each are summarised below.

Perhaps in education, of all the stage theorists, the work of Piaget is the best known (Erickson, 2000). It is important to establish that Piaget's work was concerned with development, rather than learning, and studying it, rather than accelerating it (in contrast to the CASE programme which is built on his theories of development). Piaget's interest lay foremost with questions of 'genetic epistemology' (Feldman, 1980), that is how we come to know – the nature of growth and knowledge (Piaget and Inhelder, 1964). Piaget, recognising the effect of the environment as well as maturation on cognitive development, wanted to understand how a child developed complex and sophisticated ways of seeing and acting (Feldman, 1980).

In contrast to behaviourism, Piaget's (Inhelder and Piaget, 1958) stage theory replaced the stimulus-response model with *schemata*, or cognitive constructions, explained simply as ways of thinking (Shayer and Adey, 2002). The theory includes a view that the learner progresses with age through a series of stages affording greater intellectual ability. Adey and Serret (2010) explain that progressing along the stages – from pre-operational, to concrete to formal operational – reflects increased connectivity. That is, with increasing maturation, the number of variables that can be 'held' and compared simultaneously increases. Piaget believed that people develop by using these progressively more sophisticated schemata enabling them to adapt and interact with the physical environment.

Loosely aligned with the notion of constructivism, another important aspect of Piaget's work was his theory concerning the mechanisms by which development was achieved: *assimilation and accommodation* (Piaget, 1953). Assimilation describes the continuous processing of stimuli into a pre-existing schema causing it to expand. However when a stimulus is unable to fit pre-existing schemata, and the assimilation process is no longer effective, accommodation is thought to occur. Accommodation is the process whereby schemata are reorganised, altered or created. Since the newly acquired stimulus does not fit into what is already in place, the existing schema or schemata have to be reworked or rewired to enable eventual full assimilation. Unfamiliar stimuli, or those not easily assimilated into the existing schema might be considered to cause cognitive challenge, Piaget proposed that this state was essential if accommodation and stage development were to occur – ideas returned to in Chapter 4.

Akin to Piagetian ideas of accommodation, the constructivist movement recognises students as knowledge constructors rather than passive recipients (Phillips, 1997). Erickson (2000) notes a further similarity between Piagetian theories and the concept of constructivism as being the critical mediating role of prior knowledge in interpreting new experiences. However, the specificity of this prior knowledge is different: constructivists focus on prior knowledge related specifically to the context on the new experience, whereas Piaget focused on broader understandings across schemas (Erickson, 2000). Although both theories tend to consider knowledge as relatively well-structured and fairly stable, the constructivists' focus is on bringing about change in learners.

Finally, extending on the previous theories, social constructivism emphasises the role of the environment, and the learners' interaction within it, as being crucial to personal knowledge development (Driver *et al.*, 1994). Often associated with social constructivism, Vygotsky's (1978) theories position centrally the role of social interaction, and importantly language use, in cognitive development. That is to say,

> language and other semiotic mechanisms are used to develop and rehearse meanings between individuals and provide the tools or mediational means that enable individual cognition (Scott, 2004: 74).

Although similarities between Piaget and Vygotsky's views of development/learning can be identified, Vygotsky's work emphasises the role of the teacher as central to a learner's cognitive development. Explained further, if individual consciousness is built from the outside through social relations with others, then it follows that higher mental functions are products of mediated activity. Vygotsky linked the role of the mediator to individual student learning through the concept of the 'Zone of Proximal Development' (ZPD) (Vygotsky, 1978). Situated within the learner's mind, the ZPD is, put simply, the difference between what a learner can achieve unaided, and what they accomplish through support, from another student, teacher or parent, perhaps, for example, by asking a probing question (Adey and Serret, 2010). Scott (2004:92) notes that, 'the process of internalisation is not the transferral of an external activity to a pre-existing internal plane of consciousness', rather, it is the process in which this plane is formed. This, Scott refers to as a 'knowledge plane' and it has similarities with Piaget's concept of accommodation. Furthermore, Vygotskian theory postulates that without social interaction through talk, or organised intervention, learners would not have the opportunity to reorganise, reconstruct and develop individual knowledge planes. Viewed from a social constructivist perspective, associated teacher instruction might be described as *dynamic* in contrast to *procedural*, which is more in keeping with a behaviourist approach (Hayes, 2002). That is to say, teaching might be frequently considered as interactive and changeable, depending on the teaching outcomes, compared to routine and formulaic.

Social constructivism, as discussed above, captures the traditional Vygotskian conception of 'social' as one where knowledge exists on a social plane that may arise from someone just providing information. However the concept of the 'social' has been understood in two further ways. Nespor (1994) and Lave (1996) see 'social' in terms of social cultural theory, where the educational setting is considered as fostering a type of enculturation into a particular community. Brown (1992) and Bereiter and Scardamalia (1993), however, believe it to be more akin to the establishment of dynamic, collaborative learning environments, where the focus for learning remains on the group rather than the individual. In this study, I understand 'social' in terms of the latter conceptualisation; that is, collaborative learning.

Chapter 4 sets out two pedagogic initiatives, CASE and Assessment for Learning (AfL), which both have roots in social constructivism learning theory, with each charged with changing teachers' behaviours and potential beliefs over an extended period. These particular initiatives are discussed due to their central position in the construction of this study's professional development programme and outdoor science activities.

3.3.3 Teachers' beliefs: epistemology of science

Kang and Wallace (2004) define epistemology as a philosophical study of the nature of knowledge and knowledge development. Personal epistemological beliefs are formed alongside more widely accepted subject related epistemologies (Hofer and Pintrich, 2002). Over time, subject communities' agreement about the nature of the knowledge varies; a change recognised in the epistemology of science. Discussed below are Hodson's (2008) two broad views of understanding science: the traditional inductive view and alternative views (including the ideas of Popper and Kuhn). However, as Aposolou and Koulaidis (2010) assert, such a categorisation is simplistic and made in response to limitations of space and consideration of the thesis' purpose (for a more in-depth discussion see Hodson (2008) Chapters 3 and 4). Hence, consideration is given to the epistemologies of the range of science subject disciplines. Finally, the influence of the science teachers' epistemology on pedagogical practice is considered.

3.3.3.1 Traditional inductive view

According to the traditional inductive view of science, the scientist accumulates initial observations to create theories. Siegel's description offers an insight into this 'type' of science:

> Science has traditionally been seen as the apex of rationality. The scientist, as the traditional image has it, is the dispassionate seeker of the truth – the person in the lab coat, untroubled by passion or emotion, unbiased by prior conviction, guided only by reason, patiently observing, experimenting, following the evidence wherever it leads. (1991:9)

This view is commonplace in school science textbook and laboratories (Apostolou and Koulaidis, 2010; Hodson, 2008). However, Hodson (2008), postulating that the traditional view offers a 'grossly distorted view of science and scientists' (2008: 24) – identifies three falsehoods. The first falsehood implicit in an inductive view is that observation provides a secure base of 'facts' from which scientific knowledge can be derived. This view seems to ignore that much within the world of science cannot be seen, hence the need for models. Second is the assertion that science starts with observation, which Hodson challenges by arguing that an observation requires an incentive, usually in the form of an idea/theory/prediction. The final falsehood is that science always proceeds by induction – from single observation to generalizations, laws and theories, confirmed through further observations – a position challenged in the former falsehood. Hodson's (2008) principal objection to the inductive view is that how science is perpetuated as value-free and is removed primarily from theory.

3.3.3.2 Alternative views

Contrasting the earlier description of the traditional view of science, Siegel writes:

> Contemporary research… has revealed a more accurate picture of the scientist as one who is driven by prior convictions and commitments; who is guided by group loyalties and sometimes petty personal squabbles; who is frequently quite unable to recognize evidence for what it is; and whose personal career motivations give the lie to the idea that the scientist yearns only or even mainly for the truth. (1991:45)

This description, alongside the work of scientific philosophers, such as Popper and Kuhn, offers an alternative view of scientific epistemology (Hodson, 2008; Osborne and Dillon, 2010). Discussion of the multiple views of science is beyond the scope of this thesis, hence two examples to illustrate contrasting scientific epistemologies to the inductive view are outlined: Popper's hypothetico-deductive model and Kuhn's assertion that rival paradigms view the world in different ways.

The Popperian model of science is that, at first, hypotheses are generated from existing theoretical background and then predictions are made which are tested through observation and experiment leading to the acceptance or rejection of the hypotheses. Hence, observation comes later than in the inductive model, with an initial need for imagination and creativity (Popper, 1963). Kuhn's (1970) view of science – that rival paradigms look at the world in different ways – builds on the notion that new science knowledge is dependent on what is already known. Hence, what there is to observe depends on what is known. Kuhn suggests that rival paradigms, for example physics and biology, which involve different concepts and ideas, have different priorities, thereby focusing on different things. This epistemology of science proposes that:

> there is no paradigm-independent language and there are no paradigm independent concepts, so no paradigm-independent observations can be made or paradigm-independent experiments can be performed. (Hodson, 2008:79).

Hence, making a theory-less observation is near impossible. Through the changing epistemologies of science, a question arises concerning the status of science knowledge. For example, Kuhn's science epistemology – which posits the existence of multiple interpretations and multiple theoretical constructions of the same phenomena – introduces a view of science as being tentative and fluid, sometimes referred to as 'interpretist' (Schwab, 1962). Kuhn's view is in direct opposition to the traditionalist approach in which science is presented as an 'objective' representation of reality (Kang and Wallace, 2004). If both views were presented on the 'philosophical spectrum' polarised positions of realist and relativist science might be identified (Osborne and Dillon, 2010).

3.3.3.3 Science teachers' epistemology of science

Research presents a mixed picture concerning science teachers' views of the epistemology of science. Tobin (1998) and Sutton (1996) assert that, in general, science teachers' espoused beliefs about the nature of science are in line with an inductive view. However, Apostolou and Koulaidis (2010), building on the research of Koulaidis and Ogborn (1989), found the range of positions held by science teachers made generalisation difficult. That said, Koulaidis and Ogborn's (1989) research very broadly identified biology teachers as inclining towards a realist position, whereas physics teachers inclined towards a relativist position and chemistry teachers were loosely identified as 'eclectic'. However, the validity of categorising science teachers' epistemologies of science has been questioned. For example, Larkin and Wellington (1994) (supported more recently by Mulhall and Gunstone (2008)) caution researchers from over-interpreting results indicative of any particular philosophical stance arguing that research suggests few teachers had studied the philosophy of science or reflected on their own position.

Returning to Kuhn's notion of rival science paradigms, it might be suggested that the confusion discussed above results from the fact that science teachers come from a range of science disciplines, and consider 'science' to mean different things. Stanley and Brickhouse (2001) question the 'universal nature' of science. Mulhall and Gunstone (2008) counsel that 'science' comprises a diversity of disciplines which they assert, is an issue frequently overlooked and under-acknowledged. The teachers studied in this research came from a range of science backgrounds. Furthermore, traditionally outdoor science was associated with biological studies (for example, Gayford 1985). Briefly, the epistemologies of biology, physics and chemistry are outlined and how these epistemologies are reflected in subject specific science teachers is considered.

Summarising the differences between the three main sciences is difficult. Each comprises multiple subjects, which overlap across various subject fields. A possible demarcation is the extent to which the science draws on mathematics; 'real' science is often considered as the use of mathematical formula. Mulhall and Gunstone, citing Bronowski and Mazlish (1960), express this sentiment thus:

> Our confidence in any science is roughly proportional to the amount of mathematics it employs… We feel that physics is truly a science, but that there somehow clings to chemistry the less formal odor (and odium) of the cook book. And as we proceed to biology… we know that we are fast slipping down a slope away from science. (Mulhall and Gunstone, 2008:218)

The perception, described above, is that physics is objective and realist due to the certainty achieved through numbers. Lederman (1992) presents a further difference between the sciences in terms of what are accepted as causal explanations. He illustrates this aspect by explaining that, for physics, teleological explanations are not acceptable as they are seen to anthropomorphise physical objects; however their use is common in biology. The acceptance of anthropomorphisation within biology might, it could be argued, position the subject towards subjectivity and relativism. Other notable differences are that physics has relatively few theories and that these theories are considered as highly connected and that the theories have strong predictive power. Whereas biology is often seen to be composed of many theories where relationships are thought to be relatively less well developed and generally lack predictive capacity (Rosenberg, 1985; Mayr, 1988). Chemistry's subject knowledge and methods are considered to fall between physics and biology in their nature. That is, chemical behaviours are regarded as too complex to reduce to a few physical laws but can be described using mathematical formula (Baird *et al.,* 2006).

From the discussion above it might be assumed that subject specialists promote specific science epistemologies in their pedagogical practice. For example, a physics teachers' pedagogy might be more realist in nature whereas a biology teacher might be more relativist. Research, however, does not support this assertion and a mixed picture has emerged (Koulaidis and Ogborn, 1989). One explanation for these findings involves the nature of school science – considered as lending itself to an inductive view – and its relationship with 'real' science (Hodson, 2008; Apostolou and Koulaidis, 2010). Furthermore, studies have questioned the validity of groupings such as 'physics teachers' and 'biology teachers' suggesting that individual science teachers' epistemological beliefs are determined by multiple factors (Benson, 1989).

Research suggests that other factors include teaching/learning beliefs (Tsai, 2007; Mulhall and Gunstone, 2008), length of formal science training (Pomeroy, 1993), depth of subject knowledge (Schwartz and Lederman, 2002), depth of Pedagogical Content Knowledge (Veal, 1999), formal exposure to the history and philosophy of science (Höttecke and Silva, 2011), length of teaching experience (Nott and Wellington, 1996), exposure to the National Curriculum (Swain *et al.,* 2000) and exposure to idealised models of science presented in textbooks (Brickhouse, 1989). So, although some generalisation might be possible across specific science teaching populations more widely, at an individual level, multiple factors influence teachers' beliefs of, and relationship with, science. This is an important point to keep in mind, as this thesis provides individual case studies of science teachers.

Beliefs are inferred from what is said and observed; beliefs, therefore, can remain hidden (Hodson, 1993). Kang and Wallace (2004) and Mulhall and Gunstone's (2008) findings reflect the complex relationship between epistemological beliefs of science and pedagogical practice. Kang and Wallace (2004), studying three experienced high school science teachers in the US (using 'critical incidents' developed by Nott and Wellington (1995), interviews and classroom observations), reported that teachers holding a traditional view of science, that is, scientific knowledge as one certain truth – termed 'naïve' – were more likely to pursue transmitting knowledge as a primary instructional goal and, for example, use demonstrations as a method of 'show-and-tell'. Conversely, teachers identified with alternative epistemologies of science, that is scientific knowledge as tentative with multiple truths – termed 'sophisticated' – were not always observed using practices reflecting these beliefs. The researchers postulated that preordained curriculum and external tests promoting the traditional view left 'naïve' teachers' practices unchallenged whilst restricting the pedagogical practice of those teachers holding 'sophisticated' beliefs.

In contrast to the former study, Mulhall and Gunstone (2008), studying secondary physics teachers in Australia, initially categorised teachers' practice, so that five teachers with 'traditional' and five teachers with 'conceptual' practice could be studied. The researchers explain:

> 'Traditional' teachers were those who, when teaching, were observed to focus on problem solving and explanations using algorithms with little or no consideration of development of students' understanding of concepts, beyond that provided by 'cook-book' style laboratory work. Central to this classification was the role of questions: Traditional teachers focused on seeking correct answers from students or providing these themselves. (Mulhall and Gunstone, 2008:444)

In contrast, and similar to teachers identified as having social constructivist beliefs about learning (Section 3.3.2.1), they explain:

> 'Conceptual' teachers were those who were observed, when teaching, to use approaches in which: they encouraged students to make their reasoning of a situation explicit; they encouraged students to reason through conceptual conflicts, often with the aid of peer input rather than teacher input, and to compare different ideas and decide which of a range of explanations was 'best'; there was less teacher talk and more student talk, unlike in traditional classrooms where the reverse is the case, and, the teacher's role was to ask questions to promote student engagement with ideas, rather than give answers and information. (*ibid*.:444)

Similar to Kang and Wallace (2004), Mulhall and Gunstone (2008) found that teachers with 'traditional' practice saw physics as discovered and as a close approximation of reality. However, teachers identified as having 'conceptual' practice were not necessarily found to hold 'alternative' epistemologies of science, which might have been anticipated. Instead these teachers' epistemologies of science ranged between realist and relativist – with some teachers identified as having beliefs overlapping with the 'traditional' teachers. That said, 'conceptual' teachers, were identified as having more complex views of physics than 'traditional' teachers.

From these studies, two important issues are presented. First, beliefs held are not necessary espoused in practice; teachers with traditional epistemologies of science are more likely to have teaching approaches aligned with their beliefs than those with alternative epistemologies of science. Second, as Kang and Wallace (2004) noted, alongside science epistemology, pedagogical practice is influenced by a variety of in-school factors including externally directed learning goals (for example, the exam specifications); many of these factors equally influencing teachers' professional development decisions as identified in Chapter 2. Kang and Wallace (2004) propose that the ability to manage and negotiate a landscape, where epistemological beliefs are in conflict with externally-held beliefs, is difficult.

3.3.4 Teachers' beliefs: outdoor science

This study is concerned with science teachers' practices outdoors. No research was identified that related specifically to science teachers' beliefs and the outdoors. However, three fields of literature were considered relevant, possibly informing teachers' use of the outdoors – in addition to beliefs relating to how children learn and science epistemologies. These were beliefs concerning: the role of practical work; the place of environmental education; and, the management of student learning. Each is discussed in turn in the following sections.

3.3.4.1 Outdoor science: practical work

Millar (2010), in a review of the role of practical work, notes that:

> Practical work is a prominent and distinctive feature of science education and it is not hard to see why. […] The aim of science education is to expand students' knowledge of the *natural world* and help them develop an understanding of the ideas and models that scientists use to explain its behaviour. (Millar, 2010:108, emphasis added)

If the aim is 'to expand student's knowledge of the *natural world*' and practical work is considered as 'a prominent […] feature' in school science, why then does more practical work not take place in the *natural world*? And when it does, why is the repertoire limited to data collection and teaching ecology (Gayford, 1985)? The answers might reside in the beliefs that teachers have about using practical work. Borrowing from Millar (2010), this study defines practical work as:

> any science teaching and learning activity in which the student, working individually or in small groups, observe and/or manipulate the objects or materials they are studying.
> (Millar, 2010:109, extending on Lunetta *et al.*, 2007)

Many empirical studies have sought to identify teachers' aims for the inclusion of practical work (for example, Hofstein and Lunetta, 2004; Lunetta *et al.*, 2007; Woodley, 2009). Swain *et al.* (1999, 2000) asked UK science teachers to rank reasons for the inclusion of practical work and found that the four highest ranked were: to encourage accurate observation and description; to promote a logical reasoning method to thought; to arouse and maintain interest; and, to make phenomena more real (Swain *et al.*, 1999).

The first, second and fourth reasons might be linked to teachers' science epistemology perspective – one which is inductive in nature. In fact Swain *et al.* (1999), comparing different countries responses, postulated that how practical work was used was due to a country's dominant epistemological perspective. Furthermore, the authors considered the country's curriculum aims also influenced science practical approaches.

The third reason, *to arouse and maintain interest*, in part signifies the showiness and entertainment aspect surrounding the performance of science. This belief that practical work maintains student interest was substantiated by a poll of 4,000 British students (Porter and Parvin, 2009). Similarly Donnelly (1998), having carried out 40 interviews in five secondary science departments in the UK regarding the role of practical work in science, reported that practical work, whilst offering the 'performance of science', was considered by the majority of teachers as a constitutive element of 'being a science teacher'. This notion of something that is part of your repertoire, rather than a strategy consciously chosen for learning, relates to issues of teacher identity (for an extended discussion of the concept of science teacher identity see Helms (1998)).

Consequently, when Swain *et al.*'s reasons for the inclusion of practical work are considered in the context of the outdoors, potential issues become evident. For example, where teachers believe that practical work will *encourage accurate observation and description,* the variability of the outdoors might be considered as a hindrance to achieving this goal. Similarly, a controlled laboratory environment rather than the haphazard nature of the outdoors might be more suited to achieve *a logical reasoning method to thought.* I accept that these are tentative justifications, however, when combined with other similar belief responses, a substantial cumulative influence may result.

In cases where teachers are reported as saying that they include practical work *to make science more real,* it is difficult to justify why the outdoors is not similarly used more frequently. That is, surely 'real' science is located both inside and outside the lab. The same could be asked when Millar suggested above that science is concerned with the *natural world.* However, Donnelly (1998) offers some insight into these contradictions in arguing that teachers are not particularly conscious of their reasons for inclusion or exclusion of practical work to produce intended cognitive or behavioural changes, being more preoccupied with the role of science teacher (for example, Little, 1993; Talbert, 1995; Helms, 1998).

3.3.4.2 Outdoor science: environmental education

Dowd (2009), in a study of 23 outdoor science educators in England and USA, identified three commonly shared beliefs concerning learning. First, that learning requires connectivity between the student and the environment (evident in the use of anthropomorphic reasoning methods), for example 'asking students to "think like a mountain"' (Dowd, 2009:132). Dowd reasons that educators believe students who are unfamiliar with nature will be more able to link it to themselves – thus becoming more interested in it.

The second belief concerning learning relates to authenticity and 'that learning opportunities in the natural context are superior to other more formal situations where learning always had to be mediated' (Dowd, 2009: 147). Underpinning this belief is the view that the context acts as a stimulus thereby enabling students' personal engagement leading to potential ownership of learning. Where this belief is held, outdoor science educators' discussions with students are more dialogic than 'monologic', where the context sparks student questions and students see learning as less predictable (Dowd, 2009).

The third belief relates to the two interconnected pedagogical approaches identified in outdoor science educators' practices: experimental education and 'free choice learning'. Both approaches are concerned with how learning is executed rather than what is being learnt (Dowd, 2009). The belief therefore is that the process of learning takes precedence over the outcomes – explaining the centrality of the need for authenticity. This belief held by outdoor science educators, contrasts with many classroom based science teachers' beliefs that are shaped by the outcome-based culture dominated by multiple macro-level factors (see Chapter 2). Hence, tentatively I propose that science teachers found to use the outdoors frequently might share one or more of the beliefs outlined above. A science teacher with this disposition might believe that the teaching about the environment is central to a student's education (Lucus, 1972). Teaching outside might be viewed holistically, or as Winther and colleagues explain:

> In the process [of spending time in a wood learning math, investigating science and completing literacy activities] they [the students] develop a more complex understanding of forest processes and the interactions of forest management practices and wildlife habitats. These experiences support content learning objectives in addition to promoting understanding and appreciation of ecological systems. (Winther *et al.,* 2010:33)

3.3.5 Outdoor science: managing student learning

Research I previously conducted suggested that teachers' perception of student behaviour outside and their ability to manage it might influence pedagogical decisions (Glackin, 2006; Glackin and Jones, 2012). Although all teaching requires a form of disciplinary action, might the outdoors present a different or more challenging context to manage student behaviours? Widening this discussion, momentarily, to consider constructs from sociology, Foucault (1977) describes how 'technologies of the social' are used to bring about institutional regulatory acceptance. He identifies four contrasting forms of regulatory technologies across a range of institutional settings including schools (see Foucault, 1977). Foucault's first form is particularly relevant to this study's context as he conjectures that 'discipline proceeds from the distribution of individuals in space' (Foucault, 1977: 143). To this end, he postulates that discipline employs several techniques:

> Discipline sometimes requires *enclosure*, the specification of a place heterogeneous to all others and closed in upon itself. It is the protected place of disciplinary monotony.
>
> [...]
>
> But the principle of 'enclosure' is neither constant, nor indispensable, nor sufficient in disciplinary machinery. This machinery works space in a much more flexible and detailed way. It does this first of all on the principles of elementary location or *partitioning*. Each individual has his own place; and each place its individual. Avoid distributions in groups; break up collective dispositions; analyse confused, massive or transient pluralities. Disciplinary space tends to be divided into as many sections as there are bodies or elements to be distributed. One must eliminate the effects of imprecise distributions, the uncontrolled disappearance of individuals, their diffuse circulation, their unusable and dangerous coagulation; it was a tactic of anti-desertion, anti-vagabondage, anti-concentration. Its aim was to establish presences and absences, to know where and how to locate individuals, to set up useful communications, to interrupt others, to be able at each moment to supervise the conduct of each individual, to assess it, to judge it, to calculate its qualities or merits. It was a procedure, therefore, aimed at

> knowing, mastering and using. Discipline organises an analytical space. (Foucault, 1977:143)

Keeping in mind the purpose of being in the space – to learn – Foucault's analysis offers an insight into the duality of what the space presents. That is, not only is the space organised for learning, first and foremost it is organised for control. In this study, participating teachers spent the majority of time in their classrooms/laboratories. In this setting, implicit in teachers' practice are methods monitoring student behaviours. In the familiar 'enclosure' of the classroom, teachers and students share an understanding of required behaviours. For example, teachers have routines and rules for organising students, which are particular to the space and its resources. The outdoors might thus represent an antithesis to the controlled classroom 'enclosure'.

The second sociological theorist I borrow from is Bernstein (1990; 2000) who distinguished between two approaches of social order: regulative discourse (RD), described as management to establish 'order, relations, identity', and instructional discourse (ID), described as transmitting specialised competencies which includes the teaching of school subjects. Bernstein conjectures that 'the discourse of competence' is embedded 'into a discourse of social order in such a way that the latter always dominates the former' (1990:183). Therefore RD must be enacted first. Rules and comportments for the outside need to be formulated, shared and practised. Something that is implicit in an experienced teacher's practice inside needs to become the initial focus outside.

Hence, I suggest, the extent to which a teacher believes that the enclosure is essential for learning to occur, and required to maintain control, will influence pedagogical practice outside. In addition, teachers' beliefs in their abilities to set up explicit disciplinary controls relate to teachers' efficacy (discussed further in Section 3.4).

3.3.6 Summary

Section 3.3 has attempted to organise relevant literature concerning science teachers' beliefs. Following the conceptualisation of beliefs, three broad themes were identified and discussed. The themes concerning teacher beliefs were: learning and teaching science, the epistemology of science, and outdoor science. For the final theme, due to the lack of research evidence, three related aspects were explored: practical work, environmental education and managing student learning. Section 3.4 considers a related and intertwined construct of the belief system – teacher efficacy.

3.4 Teacher efficacy

3.4.1 Defining teacher efficacy

The origin of teacher efficacy is in Bandura's (1977) theory of self-efficacy that built on Rotter's (1954) and Miller and Dollard's (1941) theories of social learning – that is, people learn through observation and internalization. From a social cognitive perspective, self-efficacy has been explained as offering an understanding of the underlying factors that affect a person's confidence and ability to achieve (Bandura, 1997). Situated within the belief system (see Section 3.1), Bandura (1997) argues that the construct occupies a pivotal role; acting upon other classes of determinants – including beliefs, attitudes and motivation. It is explained as:

> People's judgments of their capabilities to organise and execute courses of action required to attain designated types of performances. It is concerned not with the skills one has, but with the judgment of what one can do with whatever skills one possesses. (Bandura, 1986: 391)

Or more concisely, 'A context-specific assessment of performance to perform a specific task' (Pajares, 1997: 15).

Hence, whereas confidence is acknowledged as a 'nondescript term that refers to strength of belief but does not necessarily specify what the certainty is about' (Bandura, 1997:382), self-efficacy, in contrast, is a specific compound variable consisting of an outcome expectancy and a perceived self-efficacy. The former, outcome expectancy, is a person's generalized expectancy about action-outcome contingencies based on life experiences and the latter is the person's development of specific beliefs concerning their own capabilities (Bandura, 1977). Self-efficacy informs behaviour and a person's affective state.

Bandura cautioned that self-efficacy is task specific; a notion captured in Pajares' definition above, hence the emergence of profession-specific efficacy research. As Cantrell and Callaway note:

> Bandura (1977, 1986) identified teacher efficacy as a type of self-efficacy in that teachers are strongly affected by their beliefs about their potential to affect student learning, and those beliefs relate directly to their efforts and persistence with students. (Cantrell and Callaway, 2008: 1740)

In the most part, this thesis uses the term 'teacher efficacy', however, due to the concept's relative immaturity, other terms are used in the literature, sometimes interchangeably, including: teacher self-efficacy (Milner and Woolfolk Hoy, 2003), self-efficacy (Brand and Wilkins, 2007) and self-confidence (Onafowora, 2005). Furthermore, several researchers have differentiated between different efficacies in teaching, for example teaching efficacy and discipline efficacy (Cheung, 2008) and general, personal and collective efficacies (Cantrell and Callaway, 2008).

Bandura believed that behaviour could be predicted by investigating both types of expectancy determinants: outcome expectancy and perceived self-efficacy. For example, a teacher with high teacher efficacy and high outcome expectancies is thought to behave in a productive manner and gain personal satisfaction from the endeavour. In contrast, a teacher with low teacher efficacy and low outcome expectancies is predicted to exhibit a behaviour of resignation, and an attitude of apathy. Section 3.4.2 discusses further teacher efficacy and teaching traits.

In general, research findings have supported the concept and role of self-efficacy (Pajares, 1996). However, Eastman and Marzillier (1984), in their examination of the conceptual basis of self-efficacy theory, present two criticisms of the theory. First, they posit 'that the central concept of efficacy expectations is not unambiguously differentiated from the outcome expectation' (Eastman and Marzillier, 1984:213). Therefore they question the inclusion of outcome expectancy in the assessment of self-efficacy. Second, they hold reservations as to whether Bandura's empirical studies measure self-efficacy as he defines it. This issue of validity arises when other researchers have attempted to develop instruments for measurement (for example, Gibson and Dembo, 1984), a discussion which is returned to in Section 3.5. Although Bandura responded in length to Eastman and Marzillier's assertions, the authors maintain their disquiet concerning his methodology (Marzillier and Eastman, 1984).

3.4.1.1 Teacher efficacy: self-concept and self-esteem

Teacher efficacy, or self-efficacy, should be distinguished from two similar concepts: self-concept and self-esteem (Bandura, 1997). Compared to self-efficacy, self-concept is a more global construct containing many perceptions about the 'self' including self-efficacy.

Woolfolk Hoy (2004) explains that self-concept is developed in part from comparison of self to other people, using other people's abilities or accomplishments as frames of reference; whereas self-efficacy focuses on the individual's ability to successfully accomplish a particular task with no need for comparisons with others.

Self-efficacy and self-esteem differ insomuch as self-efficacy is concerned with a judgment of personal capabilities whereas self-esteem is concerned with judgment of self-worth (Pajares, 1996). Beliefs, attitudes and identity shape an individual's self-esteem. Esteem and efficacy can impact on each other, but this is not always the case. The extent to which one's self-esteem is impacted upon by self-efficacy will depend on the importance placed on the context (Woolfolk Hoy, 2004). For example, if a teacher has low teacher efficacy in their ability to teach outside, but they do not place great importance on it, their self-esteem is unlikely to be affected.

3.4.2 Teacher efficacy traits

Teachers considered to have high teacher efficacy have been observed to exhibit some/all of the following attributes and/or pedagogical practices: good subject knowledge (Riggs, 1995; Ross, 1998; Muijs and Reynolds, 2001; Cantrell *et al.*, 2003); high levels of planning, organization, direct teaching and enthusiasm (Allinder, 1994; Muijs and Reynolds, 2001); a willingness to experiment with new teaching methods and persist if initial implementation is flawed (Haney *et al.,* 1996; Cousins and Walker, 2000); less reliance on curriculum guides with increasing emphasis on cross curriculum links (De Laat and Watters, 1995); using real life examples to provide opportunities for problem solving and logical thinking, rather than prioritising the approach for 'fun' (Czerniak and Schriver, 1994; De Laat and Watters, 1995); to be likely to use potentially difficult to manage methods, such as inquiry, small group work and cognitively challenging questions, and be less likely to adopt didactic practices (Ashton and Webb, 1986; Muijs and Reynolds, 2001; Chacon, 2005); to hold relatively few controlling beliefs about classroom behaviour (Chacon, 2005; Woolfolk *et al.*, 1990); and, to be relatively uncritical of students who make errors and persist in supporting students who struggle (Gibson and Dembo, 1984; Ashton and Webb, 1986).

Caution, however, is required, as teacher efficacy cannot always be assumed by observing pedagogical practice. Furthermore, implementation of different pedagogical practices might cause a teacher to feel a range of teacher efficacies, resulting in an accumulative 'general' teacher efficacy. Different aspects of teaching can be more or less influential on 'general' teacher efficacy. For example, Mulholland and Wallace (2001) found that whilst subject knowledge influenced science teachers' efficacy and resulting practice, teacher efficacy for managing student learning was equally important. The researchers noted that teachers with high teacher efficacy for subject knowledge but low teacher efficacy for managing student learning, avoided hands-on science activities and teacher demonstrations often replaced whole-class inquiry activities (*ibid*). This finding highlights the challenges of measuring teacher efficacy, an issue that is discussed further in Section 3.5.

Inferred from the discussion above is that high teacher efficacy comes with effective pedagogical practice. Notwithstanding, Wheatley (2002) has identified benefits when teachers have doubts about their competence. Benefits include, teachers fostering reflection, being motivated to learn, being responsive to diversity, and receptive to productive collaboration (*ibid.*). Whilst it is accepted that teachers with very low teacher efficacy are detrimental to student learning, Wheatley's research suggests that a potential optimal level of efficacy might be identified. Similarly, Dewey valued uncertainty, asserting that 'it marks an inquiring, hunting, searching attitude, instead of one of mastery and possession' (1916: 296). He proposed that for a conviction in true knowledge, doubt was an essential element, driving the critical processes to revise, extend, search and reorganize.

The usefulness of doubt to practice is identified in Southerland *et al.*'s (2011b) theory of 'pedagogical discontentment'. That is, when a teacher, reflecting on their pedagogical goals and practice recognises a mismatch, a state of cognitive conflict arises enabling a state of openness to 'reform'. Chiming with Wheatley's list above, pedagogical discontentment is found to manifest itself when teachers are reflective-on-action. Southerland *et al.* (2011a) posit that teachers with very high teacher efficacy might be resistant to education reform requiring pedagogical change, and consider that a level of doubt and uncertainty are essential qualities for conceptual change. This study accepts that a certain level of self-doubt, or lowered teacher efficacy, is helpful for pedagogical practice to remain effective.

3.4.3 Teacher efficacy construction

Teacher efficacy is constructed from four principal sources of information: mastery, vicarious, verbal/social persuasion, and physiological/emotional (Bandura, 1997). Each source is outlined below alongside examples of professional development strategies identified as successfully utilising the source, resulting in a positive effect on teacher efficacy.

The first source of teacher efficacy is mastery experience: the need for an individual to set a goal and then 'muster whatever it takes to succeed' (Bandura, 1995: 3). Successes are thought to build a 'robust belief in one's personal efficacy' whereas failures undermine it (*ibid.*)[1]. For mastery experiences to occur, success should not be easy to attain, goals need to be challenging. The conjecture being that 'if people experience only easy successes they come to expect quick results and are easily discouraged by failure' (*ibid.*). The level of arousal – excitement or anxiety – adds to the feeling of mastery or incompetence.

Palmer (2011), in a recent review of research, identified mastery experiences as 'enactive' and 'cognitive'. The former – enactive mastery – refers to the act of teaching, and the latter – cognitive mastery – refers to the understanding of a pedagogical concept. To enable opportunities for these experiences, effective professional development approaches have included enhancing teacher knowledge and skills by using modeling, practice and reflection on activities prior to teaching. Palmer (2011) suggests that offering teachers a theoretical background, and time to practice, enhances the opportunity to develop an enactive and cognitive mastery once in the classroom.

The second source of teacher efficacy is vicarious experience, or more simply, observing people attempting a challenge. Bandura (1995) explains that observing others succeed through perseverance raises the observers' teacher efficacy. Conversely, observing failure, despite high personal effort, diminishes the observers' judgment in their own ability. Vicarious experiences are greater if a teacher feels the teacher/tutor being observed is similar to them in terms of skills and experience.

Vicarious experiences are accessed through modelling (Palmer, 2006). Different types of modelling have been identified as being beneficial including: 'effective actual modelling' – where an individual sees a person similar to themselves perform the task successfully; 'symbolic modelling' – where individuals are exposed to effective models provided by television and other visual media; 'self-modelling' – when the individual is recorded for

[1] This is different from mastery orientation as specified in goal theories of motivation.

subsequent self-critique, but only after the recording is edited to show the favourable aspects; and, 'cognitive self-modelling' – when individuals' visualize themselves successfully performing a task (*ibid.*). Posnanski (2002) notes that 'tutor modelling' of the desired teaching behaviours can be influential. However, rather than involving students, this type of modelling is where the tutor acts as the teacher and invites the teachers to assume the role of the students. Palmer (2006), referring to it as 'simulated modelling', found that when used with pre-service science teachers, tutor modelling acted as a source of teacher efficacy.

The third principle source is social/verbal persuasion: where one individual verbally assures another that they possess the capabilities to perform the activity. Bandura (1995; 1997) reflects that it is easier to undermine than increase teacher efficacy through verbal persuasion, whilst affirming that the potency of persuasion depends on the credibility, trustworthiness and expertise of the persuader. Social persuasion can include responses from students. It is also related to the sense of collective efficacy in a department (Milner and Woolfolk Hoy, 2003) (discussed in Chapter 2). Effective professional development strategies offering opportunities for verbal/social persuasion include: lesson feedback from site-based teachers (Ross and Bruce, 2007), programme tutors/lecturers and professional development session discussions (Posnanski, 2002; Khourey-Bowers and Simonis, 2004; Palmer, 2006).

The final source of teacher efficacy is the individual's physiological and emotional state. All individuals are thought to judge their own capabilities through these 'states'. For example a positive mood is thought to enhance teacher efficacy, whereas a despondent mood acts to diminish it. In terms of professional development, limited research has been completed in to how specific activities might be interpreted by individuals identified with particular states (Milner, 2002). Professional development strategies which have been identified as having a positive influence on teachers' emotional states are: sequencing the introduction of pedagogical strategies from the least threatening (Bruce and Ross, 2008) and consciously promoting a relaxed atmosphere of camaraderie (Khourey-Bowers and Simonis, 2004).

In the past, the majority of researchers in the field considered mastery experiences as the most influential source of teacher efficacy, identifying verbal/social persuasion as having limited/short-term influence (for example, Bandura, 1997). However, recent research suggests that it is more complicated, with factors such as teaching experience and gender influencing the effectiveness of teacher efficacy sources (Britner and Pajares, 2006; Tschannes-Moran and Woolfolk Hoy, 2007).

Teacher efficacy sources are not discrete, and significant correlations between sources are reported (Usher and Pajares, 2008). For example, Milner (2002) found that verbal persuasion operated as a critical source until successful mastery experiences occurred. However, limited attention has been dedicated to how the sources work together to inform teacher efficacy (Milner, 2002; Bruce and Ross, 2008; Klassen *et al.,* 2011). Little experimental or long-term intervention research has been conducted in this area (Henson, 2002). The few studies that have investigated activities to enhance science teacher efficacy have been dominated by pre-service primary education (for example, Palmer, 2006; 2011) – possibly due to the ease of access to the study group, and the elevated concern towards the groups' level of confidence concerning science teaching (Tosun, 2000).

Finally, concerning teacher change more generally, Henson (2002) conjectures that, as time passes, teacher efficacy solidifies, resulting in the requirement for longer-term professional development. Furthermore, research has shown that particular types of professional development enable teacher efficacy, whereas others prevent it. For example, Henson (2001) reports that, following a year-long 'teacher as researcher' initiative, changes in personal and general teacher efficacy were measured. The study asserts that collaboration between teachers was advantageous to teacher efficacy (see Chapter 2 for a discussion of collective efficacy). These findings are in contrast to Ross *et al.*'s (1997) study which followed an externally implemented reform, whereby teachers were treated as subjects and not as researchers, which led to a decline in teacher efficacy.

3.4.4 Summary

This section has presented the belief system construct – teacher efficacy. Following an exploration of the origins of teacher efficacy, the construct was compared to similar concepts in the field. Teacher traits and pedagogical practice were presented as having been identified across the research literature for those with high teacher efficacy. Sources of teacher efficacy, and how they might be related to potential professional development strategies, were discussed.

3.5 Measuring beliefs and teacher efficacy

Surveying the literature, the methods used to investigate teachers' beliefs and teacher efficacy over the past three decades have been dominated by quantitative methodologies. Klassen and colleagues (2011), in a review of teacher efficacy research (1998-2007), reported that only 8.7 per cent (n=19) of studies of teacher efficacy were conducted using qualitative methods. This situation led Labone to comment that 'the paradigms of the interpretivists and the critical theorists have been somewhat neglected' (2004: 342).

Quantitative instruments, including Likert scales (preference ranking) and semantic differentials (attitude scales), are common in the vast range of validated surveys and standardised protocols concerning science teachers' beliefs and teacher efficacy. Examples are, Attitudes and Beliefs about the Nature of and the Teaching of Mathematics and Science (McGinnis *et al.,* 2002), Context Beliefs and Teaching Science (Lumpe *et al.*, 2000) and Science Teacher Efficacy Beliefs Instrument (STEBI) (Riggs and Enochs, 1990). It has been suggested that the dominance of the quantitative approach has been due to several factors including: ease-of-use, transferability and how the fact that multiple questions can be used to measure the same construct – thus increasing reliability (Gardner, 1996; Osborne *et al.,* 2003). Richardson's (2001) comment that instrument adaption is a result of the changing 'elusive' construct's definition, highlights a weakness in the method. That is, the lack of clarity surrounding construct validity – the extent to which a scale represents what it claims it represents – results in questionable reliability.

The STEBI (Riggs and Enochs, 1990), an instrument to measure science teacher efficacy, continues to evolve and change (for example, the STEBI-CHEM to measure teaching confidence in teaching chemistry (Rubeck and Enochs, 1991) and SEBEST to measure teacher beliefs towards science teaching and learning in regard to considerations of ethnicity, language minorities, gender, and socioeconomic factors (Ritter *et al.,* 2002)). Originating from earlier instruments such as RAND (developed by researchers at the RAND corporation; Armor *et al.,* 1976), Teacher Efficacy Scale (Gibson and Dembo, 1984) and Ashton *et al.*'s (1984) vignettes, the STEBI offered context/subject specificity that previous instruments lacked. Similar to the previous instruments, the STEBI consists of a two-scale dimension reflecting Bandura's assertion that teacher efficacy is a compound variable (see Section 3.4.1). The scales are termed personal science teaching belief scale, the perceived self-efficacy dimension (SED) and science teaching outcome expectancy, the outcome expectancy dimension (OED). The original instrument was specific to science teaching with two versions designed for in-service (STEBI-A) and pre-service (STEBI-B) teachers. The STEBI consists of 23 items: thirteen statements relate to the SED dimension, ten relate to OED. Bleicher (2004) reconfirmed Riggs and Enochs' (1990) findings of high reliability and validity for the statements, identifying only two statements that presented possible ambiguity.

Highlighted above were general problems concerning instrument development for belief system constructs. However, in terms of teacher efficacy, Pajares (1996) asserts that the challenge is to find the optimal level of specificity for a measure. That is, ensuring that a measure's predictive power is not lost due to the specificity in skills and context being measured (rendering it useless for comparisons across teachers, classes, and subjects), nor that it is too general so that only broad comparisons can be made. The second and related challenge is the validity in the use of single-item measures that are able to capture the multifaceted dimensions of teacher efficacy (Wheatley, 2005). In response to these problems there has been a gradual shift towards qualitative and mixed-method research approaches (for example, Luft and Roehrig (2007), Lee *et al.* (2007) and Cross (2009)).

Instruments, such as those discussed above, led Wheatley to comment,

> Perhaps because teachers' efficacy beliefs have so often been operationalized through quantitative scales, the *de facto* meaning of "teacher efficacy" has become a numerical level of confidence. (2005:749)

Klassen *et al.* (2011) assert that, although currently underused, qualitative approaches offer a deeper understanding of how teacher beliefs and teacher efficacy operate. Previous approaches and data-gathering procedures include case studies (Milner and Woolfolk Hoy, 2003), phenomenology (Czerniak and Schriver, 1994), school observations (Milner and Woolfolk Hoy, 2003; Ross and Bruce, 2007) – including the use of standardized rubrics (Tytler *et al.,* 2004), written reflections (Brand and Wilkins, 2007), individual interviews (for example, Cantrell and Callaway, 2008), open-ended questions on a questionnaire (Onafowora, 2005) and videotaping (Bryan and Recesso, 2006). In the past, qualitative data has been used to substantiate findings from quantitative instruments (for example, Czerniak and Schriver (1994) and Palmer (2006)). However, this process has become increasingly less common (Klassen *et al.,* 2011).

Usher and Pajares assert that qualitative inquiry,

> [..] provides a phenomenological lens through which the development of efficacy beliefs can be viewed, and it can capture the personal, social, situational, and temporal conditions under which students cognitively process and appraise their beliefs and experiences. (2008: 784)

The drawbacks of using qualitative approaches, including issues of researcher interpretation and objectivity, are discussed in Chapter 5.

3.6 Chapter summary

This chapter has presented teacher beliefs and teacher efficacy as components residing in the belief system. It has been argued that the components inform, and are informed by, pedagogical practice. Hence, the relationship is considered bi-directional and continuous. Whilst teacher beliefs and teacher efficacy are often reflected explicitly in pedagogical decisions – both articulated and observed – this study accepts that this is not necessarily always true. External sources – the meso-level and micro-level (as discussed in Chapter 2) – are influential. That is they are able to change, as well as mask, an individual's belief.

For the purpose of this study, beliefs have been conceptualised as: multiple, interrelated and malleable. I conjecture that beliefs can be ordered along a central peripheral dimension – some beliefs being more 'core' than others. Core beliefs are considered more influential on decision-making than those more peripheral; the former beliefs were considered less malleable than the latter.

The literature examined concerning teacher beliefs specific to this study included: teaching and learning, the epistemology of science, and beliefs related to the outdoors. Noteworthy was research suggesting that teachers espousing social constructivist pedagogical practices hold a range of epistemologies concerning learning, whereas teachers espousing traditional pedagogical practice hold traditional (realist) epistemologies. Researchers propose that teachers' abilities to manage and negotiate a landscape in which epistemological beliefs are in conflict with externally held beliefs can be challenging. This study is concerned with a professional development programme informed by a social constructivist framework hence it will be of interest to study how participants with a range of beliefs are influenced by, and interpret the programme.

The professional development programme is focused on the context of science outdoors. No literature was found concerning teaching science outdoors and teacher beliefs. However three belief types were considered as potentially influential on teachers' practices outdoors; they were, practical work, environmental education and managing student learning.

Confidence is a general concept, whereas teacher efficacy offers a specific compound variable – consisting of perceived teacher efficacy and outcome expectancy – identified as measureable. The traits and pedagogical practices of teachers with high teacher efficacy were outlined and the literature will be used in constructing a teacher efficacy framework (Chapter 5). Teachers with high teacher efficacy were identified as having good subject knowledge and child-centred approaches. However, it was acknowledged that some self-doubt, or lowered teacher efficacy, was advantageous for teachers to be open to pedagogical change. Sources of teacher efficacy were compared to professional development strategies, which will be useful for the analysis of this study's professional development programme (discussed further in Chapter 4 and 5). Finally, research methods used to capture the elusive concepts were briefly discussed. A further discussion can be found in Chapter 5.

This chapter has considered beliefs and teacher efficacy separately, reflecting how the constructs are presented in the literatures. However, the belief system components are intertwined, and this study is interested in not only the influence of the components during the professional development programme but also how they might interrelate. This study's findings will add to the limited literature concerning teacher beliefs and teacher efficacy in secondary science teachers, specific to the outdoors. Chapter 4 describes the pedagogical framework, structure and strategies of this study's professional development programme – 'Thinking Beyond the Classroom'.

Chapter 4 'Thinking Beyond the Classroom' Professional Development Programme

4.1 Introduction

In Chapter 2, the key characteristics of effective professional development programmes were summarised as including: an underlying pedagogical framework for the activity/idea promoted (Adey, 2004); a theoretical base for the programme; and approaches considered transitional/transformative, rather than transmissive (Kennedy, 2005). This chapter describes four outdoor professional development programmes, comparing them to the characteristics outlined above before turning to consider the pedagogical framework of this study – 'Thinking Beyond the Classroom' – whilst reflecting on its underpinning theoretical base. The chapter also sets out the programme structure including the range of strategies used. Whilst the chapter offers an insight into the study's professional development programme context, it also foregrounds an aspect of the analytical approach used to investigate teachers' beliefs, teacher efficacy, pedagogical practice and professional development strategies (discussed in Chapter 5).

4.2 Previous outdoor science professional development programmes

In Chapter 1 it was proposed that to develop effective outdoor professional development programmes, a greater understanding was required of their theoretical frameworks as, too often, researchers focused on the quantity of hours spent outside, rather than on the quality of the programme's content (for example, O'Donnell *et al.* (2006)). Hence, described below are four recent 'effective' programmes from the UK that aimed to develop teachers' pedagogical practice outside the classroom.

'London Outdoor Science' (Glackin, 2007) and 'Teaching Ideas for Fieldwork' (in Bradford and Leeds) were one-year programmes established by the Field Studies Council[2] and the British Ecological Society[3], both of which involved an 'expert' working directly with secondary school science departments to develop teaching resources for their grounds/local parks in line with examination specifications. The 'experts' were qualified teachers experienced in outdoor education. The approach varied, depending on the school's need and context. Professional development models used included: 'coaching/mentoring' –

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[2] The Field Studies Council (FSC) is an educational charity committed to bringing environmental understanding to all. It offers professional development courses across 18 field centres.

[3] The British Ecological Society (BES) is a member-organisation set-up to advance ecology (britishecologicalsociety.org).

in which expert(s) worked directly with teachers to team-teach and develop materials – and 'communities of practice' where science departments, initially working with the expert, collaboratively developed their own resources and schemes of work (Glackin, 2007).

The third programme, 'Teach in Nature', was an action research initiative led by the University of Stirling in Scotland. Rather than being expert-led, the programme aimed at identifying successful approaches teachers used to incorporate the local outdoors into lessons. Teachers across all age ranges and subjects, including secondary science, were involved. Encouraged to work with colleagues through 'collaborative action enquiry' (Mannion *et al.*, 2011), teachers developed their expertise through actively planning, executing and reflecting on lessons taught (www.teachinginnature.stir.ac.uk). The programme coordinators encouraged teachers to share and publish their findings.

The final programme is the Hampshire Trailblazer Project: 'an award scheme promoting outdoor learning and environmental education for young people' (hants.gov.uk/education/trailblazer). It offers primary and secondary schools a structured programme of activities designed for outside the classroom, designed to be incorporated across the whole school curriculum. To join the scheme, and receive the activity folder, a school Trailblazer coordinator is required to attend a one-off training day, cascading the information to colleagues on returning to school. Although many teachers have received no 'direct' face-to-face contact, teaching the activities was reported as substantial professional development (Nundy *et al.*, 2009). Teachers, who identified themselves as "Trailblazers", viewed their involvement in the programme as an aspect of professional development rather than as a process of adopting a set of activities or tasks to complete (*ibid.*).

Evident across the four programmes was a distinct lack of an articulated pedagogical framework or a theoretical base (and in some cases both), which Wilson and Berne (1999) comment is a common occurrence generally across professional development programmes. For example, in the Trailblazers project, a clear structure of pedagogical practice was offered through the activities, however no clear structure was offered for the professional development, or a rationale for the lack of structure. In contrast, the 'Teach in Nature' programme offered a theoretical base for the professional development programme – action research – but offered limited direction for the development of pedagogical practice. However, as Adey (2004) notes, although programme frameworks might be unarticulated, they are all products of providers' beliefs. Hence it is noteworthy that shared between the programmes was an emphasis on the requirement of sufficient time for pedagogical change, and the necessity for teachers to work together. Both strategies were highlighted in Chapter 2 as being beneficial to teachers' practice and were implemented in the 'Thinking Beyond the Classroom' programme.

4.3 The 'Thinking Beyond the Classroom' pedagogical framework

'Thinking Beyond the Classroom' was aimed at enhancing in-service secondary science teachers' pedagogy outside the classroom. In contrast to the programmes described above (Section 4.2), the programme's activities were underpinned by elements of two pedagogical approaches with evidence for enhancing student attainment – Cognitive Acceleration through Science Education (CASE) (Shayer and Adey, 2002) and Assessment for Learning (AfL) (Black and Wiliam, 1998).

The CASE intervention programme was designed to develop and promote children's thinking skills through science (Adey *et al.*, 2001). As the name suggests, the approach comes from a cognitivist perspective – underpinned by Piaget's theories of child development and Vygotsky's concept of a 'Zone of Proximal Development' (both theories are outlined in Section 3.3.2.1). The original intervention lessons were framed around the five 'pillars' of CASE, which the authors note 'describe cognitive activities the teacher needs to promote at the appropriate parts of the lesson' (Adey *et al.,* 2001:13). The 'pillars' are: concrete preparation, cognitive conflict, construction, metacognition and bridging. Adey (2004), borrowing from Cuban's (1988) categorisation of teacher change, considers CASE innovation as second order rather than first order. That is, rather than it being a programme which results in teachers continuing to do what they already do, but just a bit better, CASE requires teachers to do something different – something difficult but not impossible.

The second approach this study's programme borrowed from was Assessment for Learning, or formative assessment, that is:

> Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited. (Black and Wiliam, 2009: 9)

Rather than CASE's distinctive form of instruction, with its explicit theoretical basis resulting in definable pedagogical practices, formative assessment, whilst considered more ubiquitous, is less easily definable, across normal classroom work. Black and Wiliam (2009), reflecting on their early review of formative assessment research note that, rather than starting from a pre-defined theoretical base, as CASE had done, their work was informed by teachers' practices. This starting point resulted in a pragmatic list of four activities considered formative in practice. They were: questioning, written feedback, peer and self-assessment, and the formative use of summative tests (Black *et al.*, 2002). Working towards a theoretical framework of Assessment for Learning, Black and Wiliam proposed that:

> any theory must bring into relationship the three spheres, the teachers' agenda, the internal world of each student, and the inter-subjective. (2009: 26)

Whilst they acknowledge that a wide number of theories across diverse traditions need consideration, the interaction of teachers and students leading to an understanding informing the next learning steps might be considered to have roots in social constructivist theories.

4.3.1 The principles of 'Thinking Beyond the Classroom'

By building on the two approaches above, the 'Thinking Beyond the Classroom's' pedagogical framework was informed by a social constructivist perspective. Due to the iterative nature of the activity design and programme construction (discussed in Section 4.4), four principles of the pedagogical framework emerged. They were: observing the local, collaborative group work, challenging thinking and learning through questioning. The principles underpinned the ten activities and became a focus in the professional development sessions. (Appendix 2 presents five activity lessons). The following section outlines each of the principles (for a fuller account see Glackin and Serret (2011)). Table 4-1 summarises the practices considered characteristic for the pedagogic principles.

The first principle that the programme activities incorporated was scientific observation – or more specifically observing science in the local area. Chapter 3 highlighted that the purpose of scientific observation depended on the epistemological perspective taken. Informed by social constructivist approaches, this programme viewed scientific observation as subjective, in that it was influenced by past experiences, group interactions and lesson objectives (Johnston, 2009). The intended outcome of the principle was to encourage student awareness of the complexity of observing – within the context of the outdoors. That is, observation is multi-staged, requiring the observer to look across the landscape whilst focusing attention on a particular feature. Furthermore, as discussed in Chapter 1, scientific observations occurring in local and familiar settings were considered as contributing to students' sense of belonging (Jack, 2010) and their 'scientific' associations in the outdoors (Rappaport, 1978).

Collaborative group work, the second principle, involved the students working together on a challenge that was given to them. Teachers provide support by encouraging group rule construction, setting group challenges and assessing group, rather than individual, work. (For a videoed example of a teacher using these principles see: azteachscience.co.uk). This type of pedagogy was aligned with Vygosky's social constructivist theory. Research suggests that teachers need more professional support in establishing classes where students work effectively in groups (Kutnick *et al.*, 2005).

Challenging thinking, the third principle, is similar to the CASE pillar, cognitive conflict, which has been described as 'an event or observation that the students find puzzling and discordant with previous experience or understanding' (Adey and Shayer, 1994: 62). Adey and Shayer suggest that cognitive conflict is 'a feature both of Piaget's account of the impact of environmental stimulus and children's constructivist response on cognitive growth' (*ibid.*:62). The authors stress that for challenge to be effective, teachers need to ensure the context in which the conflict is introduced is familiar to the students and ensure that, whilst presenting a real cognitive demand, the challenge is not too extreme or incomprehensible. For example, a number of alternative ideas emerged when students were shown a range of images from their local environment – lichens on pavements, pigeons in the playground, a puddle of water on the pavement – and asked to decide which pictures were habitats (see Appendix 2c). These conflicting ideas were then explored in the context of an investigation in the local environment whereby teachers asked: '*How do you decide if somewhere is a habitat? Do you think there are any habitats in our school? What would you look for, what kind of data would you collect?*' Whilst relating back to Vygotsky's idea of ZPD, where cognitive development occurs only within a defined range, the teachers were required to continually assess the students – requiring Assessment for Learning strategies.

The final principle incorporated into the activities was learning through questioning, one of the four activities consistent with the Assessment for Learning approach (see Section 4.3). From a social constructivist perspective, asking open questions – for example, 'how is it similar or different to….' – allowed teachers to elicit students' current conceptualisations, offering the students an opportunity to consider what they did and did not understand, and requiring students to listen to one another. The teachers' role was to facilitate, rather than lead, thus encouraging students to answer in extended prose and listen to one another. In general, as DeWitt and Hohenstein (2010) have argued, open questions encourage student initiative and control over the task, whereas closed questions indicate a teacher-centred approach which results in less higher-order thinking. Scott and Mortimer (2004) reflect that when learning through questioning occurs, talk will be in the form of: initiate (teacher (t)) – response (student (s)) – prompt (t) – response (s2) – *etc*., rather than the more usual: initiate (t) – response (s) – evaluate (t). Scott and Mortimer (2004) proposing that the former talk pattern requires students to listen to one another.

Table 4-1 Practice characteristic for pedagogic principles

Pedagogical framework principle	**Examples of teaching practices characteristic of implementation**
Observing the local	Teaching occurs outside for an extended period Students encouraged to explore everyday variety of ways Students challenged to go beyond one-word descriptions Students encouraged to look at the broader context for explanations
Collaborative group work	Pre-planned groups Students encouraged to write group working rules Students encouraged to evaluate and adapt working rules Sets and assesses group work
Challenging thinking	Students are presented with a puzzling event or situation The challenge is set-up in a 'familiar' context – so the focus is on the challenge rather the equipment, new language or new environment Questions, and prompts, are used to guide students Student response inform further questions and prompts
Learning through questioning	'Open questions' are asked which facilitate discussion 'Wait time' is used to enable students to think and discuss

	ideas Class talk encourages student listening Talk pattern used: initiate (t) – response (s) –prompt (t) – response (s2) – *etc*.

Table 4-2, below, shows the structural features used to construct the ten activities aligned with the relevant underpinning pedagogical principle. Each activity has four distinct sections which are carried out in turn. In terms of timing, the activities are designed to fit into a typical school science lesson.

Table 4-2 Activity lesson structure and pedagogical principles

Activity structure	**Pedagogical framework principle**
Setting the scene	Collaborative group work
Observations outside	Observing the local
Sharing ideas and provoking conflict	Collaborative group work Challenging thinking Learning through questioning
Linking ideas together	Collaborative group work Learning through questioning

The activities were initially developed for Key Stage 3 (11-14 years) science lessons, with explicit links to Science in the National Curriculum. However teachers adapted the lessons and reported using them with Key Stage 4 (14-16 years) and A-level (post-16) classes. The activity topics included aspects of biology, chemistry and physics. Appendix 3 presents a list of the activities together with their related scientific concepts.

4.4 'Thinking Beyond the Classroom' theory, structure and form

There were two overarching aims for the 'Thinking Beyond the Classroom' programme. First and foremost was the development of science teachers' skills in teaching outside the classroom. The second was to co-construct with the participating teachers ten outdoor science activities. The aims represent a social constructivist approach to the professional development, in terms of the teachers working with tutors, colleagues and students to create and refine activities whilst simultaneously developing their own teaching skills. Furthermore the participating teachers would draw on past teaching experiences, and it was acknowledged that the course outcomes were dependent on these experiences. The social constructivist theoretical base mirrors the approaches of Bell and Gilbert (1996) and Adey (2004) discussed in Chapter 2. The programme's theoretical base was also similar to that which underpinned the programme's pedagogical framework principles – a relationship other programmes have reported (Desimone, 2009).

'Thinking Beyond the Classroom' reflected the transitional/transformative professional development model (Kennedy, 2005). That is, the course offered opportunities for: an extended and continuous period for pedagogical change (two years), strong links between theory and practice, strategies to prompt reflection on practice, the application of practice in different contexts and the potential to build a 'community of practice'. The following sections describe the strategies that enabled these opportunities both during the sessions and in school. First the professional development programme is described.

4.4.1 'Thinking Beyond the Classroom' context

'Thinking Beyond the Classroom' was a joint venture between King's College London and the Field Studies Council which was funded by the AstraZeneca Science Teaching Trust (www.pstt.org.uk). Over a two-year period (October 2007-July 2009), science teachers from ten science departments in London state-funded schools were supported through six three-hour professional development sessions. Furthermore, two in-school observations by King's tutors were offered to enable the development of the activities. Chapter 5 outlines details concerning the participants and how they were recruited.

The venues for the sessions were deliberately varied to give participating teachers an opportunity to experience a range of out-of-classroom educational sites across London with the intention to demonstrate that no 'special' space was required to teach science outside. Table 4-3 presents the session dates and venues.

Table 4-3 Professional development programme session dates and venues

Programme session date	Programme session venue
October 2007	Mile End Ecology Park
March 2008	Camley Street Natural Park

June 2008	King's College London – Waterloo Campus
October 2008	Camley Street Natural Park
February 2009	Natural History Museum – the Wildlife Garden
June 2009	Chelsea Physic Garden

Table 4-4 lists the tutors involved in the development, teaching and in-school observations during the programme. Noteworthy is that many of the tutors were recognised nationally as experts in their field, which in terms of teacher efficacy, was a potential source for 'authentic' verbal persuasion (Palmer, 2006).

Table 4-4 Programme tutors' affiliation and expertise

Programme tutor	Affiliated organisation	Expertise
Jen DeWitt	King's College London	Out-of-classroom learning (Internal evaluator – see Section 5.4.9)
Justin Dillon	King's College London	Professional development programmes; out-of-classroom learning; CASE
Annie Duckworth	Field Studies Council	Outdoor learning
Chris Harrison	King's College London	Assessment for Learning; CASE
Melissa Glackin	King's College London	Outdoor learning; CASE
Natasha Serret	King's College London	Assessment for Learning; CASE
Steve Tilling	Field Studies Council	Outdoor learning

4.4.2 'Thinking Beyond the Classroom': the sessions

The sessions aimed to introduce participating teachers to draft versions of the 10 outdoor science activities written by the tutor team and to prompt feedback to be shared once activities were trialled. Teachers' feedback, whilst used to refine the activities, also informed other participating teachers' practices. Included in each of the sessions was a focus on one, or more, of the pedagogical principles underpinning the activities (see Section 4.3). Furthermore, the session focus varied over the two-years, responding to teachers' requests, teachers' emerging expertise and tutor in-school observations of the trialling of activities. For example, managing student learning outside became an explicit session focus following teacher feedback. Appendix 5 presents an example of a session programme.

Table 4-5 presents an overview of the range of planned strategies used in the sessions. Its purpose is to offer an insight into the structure of the 'Thinking Beyond the Classroom' programme – and therefore an understanding of what the participants might have experienced. An extended analysis of the strategies is presented in Section 5.5.5.

4.4.3 'Thinking Beyond the Classroom': in-school

Research suggests that professional development is more successful when teachers work with colleagues (for example, Shulman and Shulman (2004); Adey (2004)). Hence, science departments invited to take part in the programme were encouraged to allow pairs of teachers to participate (see Section 5.4.1.1 for an explanation about how schools were chosen). Between sessions, teachers were asked to trial at least one activity with their students and to evaluate the effectiveness of the activities. Reflection journals were distributed, with prompt questions, to capture these reflections (see Appendix 4 for prompt questions).

When tutors visited schools, the focus of the observations was on the effectiveness of the activity rather than on the teachers' pedagogical practice *per se*. Although the activity and the pedagogy are interrelated, tutors ensured that the discussion remained focused on developing the draft activity. Finally, participating teachers were invited (and supported financially) to present the activities at the Association of Science Education (ASE) regional and national conferences. These presentations were included as a planned professional development strategy as they were thought to offer participating teachers an opportunity for further reflection. Table 4-5 summarises the planned in-school strategies from 'Thinking Beyond the Classroom'.

Table 4-5 Planned professional development strategies

Programme context	**Planned strategy**
Session	Trialling activities
	Reading through activities and 'props' presented
	Group discussing and evaluating an activity
	Activity props/resources distributed
	Prepared activities to trial

	Clear pedagogical framework - transferable to other lessons
	Sequence of sessions with follow-up/review
	Tutor presenting theoretical and practical ideas
In-school	Generally trialling activities
	Adapting activities with a range of classes
	Sharing ideas with a colleague
	Observing colleagues
	Lesson observation discussion with tutor
	Sharing activities with department: formally/informally
Other	Reflecting in journal
	Presenting at conferences

4.5 Chapter summary

For the purpose of this thesis, professional development was conceptualised as a planned *action* aimed at changing the practice of the teacher for the advancement of *their learning* (see Chapter 2). Characteristics of effective professional development included: an underlying pedagogical framework for the activity/idea; a theoretical base; and a transitional/transformative model. This chapter has considered how these characteristics appear in 'Thinking Beyond the Classroom' – the focus of this study.

The pedagogical framework of the activities and the theoretical base were recognised as taking a social constructivist approach. For example, the professional development occurred over an extended period between sessions and the participants' schools, emphasising the advantages of working with colleagues across both sites. Furthermore the programme's focus was on co-construction of activities requiring teachers' experiences to feedback into the development of lessons. A further point regarding the perspective informing the pedagogical framework was revealed in the principle 'observing the local'. That is, scientific observation was considered as subjective and varying dependent on the observers' perspective, a view which might be considered similar to that of Kuhn's scientific epistemology – that rival paradigms look at the world in different ways (discussed in Chapter 3).

This chapter has discussed potential professional development strategies available to participating teachers. It was not assumed that all participants would engage with all of the strategies. Chapter 8, through the case studies of teachers (described in Chapter 6), analyses the strategies and factors that influenced participants' pedagogical practice. First, though, Chapter 5 outlines the participants represented in the case studies and outlines the study's methodology and methods.

Chapter 5 Methodology and Methods

5.1 Introduction

The aim of the study was to explore the relationships between science teachers' beliefs, teacher efficacy and pedagogical practice during the 'Thinking Beyond the Classroom' professional development programme (described in Chapter 4). In setting out to investigate such a relationship, the research questions were:

1. What is the interplay between teachers' beliefs, teacher efficacy and pedagogical practice?
2. What professional development strategies are significant in influencing teachers' practice?
3. How do teachers' beliefs and teacher efficacy influence responses to professional development programme strategies identified as significant in changing practice?

This chapter describes and explains the study's methodological framework and the data collection methods employed. Responding to the research questions above, the process of data analysis is explored. Finally, the 'trustworthiness' (Denzin and Lincoln, 2008) of the study's findings, including ethical considerations, and the duality of the researcher's role are discussed.

5.2 Social constructivist paradigm

Research methodology, informed by ontological and epistemological positions, has direct influence on the construction of research questions, research design and methods, analytical approaches and the findings that emerge (Blaikie, 2007). Owing to their complex nature, methodologies are often noted as difficult to articulate, demanding that the researcher lay bare their values and assumptions of reality to acknowledge 'that they [their values] serve as a rationale for research and the standards or criteria the research uses for interpreting data and researching conclusions' (Bailey, 1994: 34).

In this study, through the process of developing the literature reviews (see Chapter 2 and 3), the methodological approach moved into focus. As with most educational research, this thesis was influenced by several fields including psychology (for example, Bandura's research concerning teacher efficacy) and sociology (for example, Foucault's research concerning the management of people in a space). This study's research epistemology took a position aligned with social constructivism. That is, the research approach was neither at one extreme – the belief of indisputable facts – or at the other – where the material world is considered as nothing more than creations of the human mind (Gibbs, 2002). Rather, in taking the constructivist approach, it was assumed that the teacher participants were active interpreters of the world (Ball, 2004) resulting in the construction of multiple realities (Denzin and Lincoln, 2008). To this end, reflecting the theories of Vygotsky (discussed in Chapter 3), social constructivists consider language as an important mediator for meaning-making (Blaikie, 2007). Denzin and Lincoln (2008) propose that enquires approached from a social constructivist position are naturalistic. That is, studies are focused on 'people doing things together in the places where these things are done', whereby 'the site is constituted through the researcher's interpretive practices' (*ibid.*:37). Hence, from a naturalistic social constructivist perspective, this study's findings are not claimed as indisputable. It is accepted that findings might differ if another researcher were to collect and analyse the data, with the same research intention, within the same context – as all actions require interpretation (Section 5.6.2 discusses 'Trustworthiness'). (However, as Denzin and Lincoln (2008) have argued, all research, to some extent, is interpretive – being guided by researchers' beliefs and feelings about the world.) Hence, this study aimed to offer the potential of new insights – rather than answers – into teachers' pedagogical practices. Schwandt, capturing this complex process asserts:

> The inquirer must elucidate the process of meaning construction and clarify what and how meanings are embodied in the language and actions of social actors. To prepare an interpretation is itself to construct a reading of these meanings; it is to offer the inquirer's constructions of the constructions of the actors one studies. (1994: 118)

5.3 Multiple case study approach

This study used a multiple case study approach to explore the research questions. The approach was chosen to enable an exploration of the influence teachers' beliefs and teacher efficacy had on pedagogical practice and the wider influence of professional development programme strategies. Stake (2005) defines the case study as a 'bounded system' (p.444) with Berg (2009) suggesting it is concerned with a particular person, social event or group. For this study, the bounded case study was the individual teacher who had completed the 'Thinking Beyond the Classroom' professional development programme. The programme was the study's backdrop (Bryman, 2004) and the bounded time was almost two years (October 2007-July 2009). Notwithstanding, Stake (2005) asserts that defining boundaries – where a case starts and ends – is not always easy. For example, in this study defining the boundary between case study teacher and professional development programme was not always without complication.

Multiple types of categorisations of the case study have been recognised (Cohen *et al.*, 2007). Stake (2005) proposes two categories, *intrinsic* and *instrumental.* Intrinsic case studies concern understanding the particular case *per se*, whereas instrumental case studies provide an insight into an issue. This study is concerned with developing *instrumental* case studies – in that the 'rich description' (Becker, 1970) of the case is considered to offer a supportive role to insights of phenomena and potential theory development (Bassey, 1999; Creswell, 2007). Woodside and Wilson (2004), in a review of case study literature, comment that this use is increasingly becoming the function of this type of research.

This methodological approach required caution, as suggesting that the case study might lead to theory building could be considered an alignment with a positivist view, where the 'process is directed towards the development of testable hypotheses and theory which are generalizable across settings' (Eisenhardt, 2002: 28). Rather than sweeping generalizations and grand theories, the case study with its constructivist approach offers contextual insights adding to humanistic understanding (Stake, 1980). Patterns, similarities and differences might be reported and insights might be understood through previous theories or new avenues for exploration might be opened up.

The form of the research questions suggest that some logic is anticipated, that is few human behaviours are 'unique, idiosyncratic and spontaneous' (Berg, 2009:329). However the contextual uniqueness of the case study must also be kept in mind. Berg's explanation is useful when he notes that the case study affords:

> sensemaking in the manner by which people, groups and organisations make sense of stimuli with which they are confronted, how they frame what they see and hear, how they perceive and interpret this information, how they interpret their own actions and go about solving problems and interacting with others. (2009: 319)

This study took a collective, or multiple, case study approach (Stake, 2005). Six individual case studies were developed. Section 5.4.1 discusses participant recruitment to the professional development programme and the selection of case studies. However, as with other research studies, individual case studies were not identified in advance (Stake, 2005). The cases were instead chosen to provide a broader insight to the research issue – which Berg (2009) postulates offers a richer and improved understanding of the phenomena. Hence, the case study participants were required to have engaged in the programme for two-years – an impossible requirement to predetermine.

5.4 Research design

5.4.1 Case study selection

The six case studies were the result of several ‘selection’ processes. The term ‘selection’ is used broadly in that teachers were considered to self-select, rather than be selected by the researcher. Selection is discussed below: firstly in terms of the initial recruitment of teachers to the ‘Thinking Beyond the Classroom’ programme, and then to the identification of six case study teachers.

5.4.1.1 Teacher recruitment to the programme

Eighteen secondary science teachers from 10 secondary schools across Greater London were originally recruited to the ‘Thinking Beyond the Classroom’ programme. Of the 18 teachers, 16 were recruited as pairs of teachers from the same science department of 8 schools. Three methods were employed to recruit teachers to the programme. First, schools were approached that had previously been involved in ‘London Outdoor Science’ – an FSC project that developed activities for Key Stage 4 (14-16 years) science (see Section 4.2). It was anticipated that departments previously involved in teaching outside might consider the opportunity for further professional development. Second, all secondary schools in one local authority were invited. The focused invitation was the result of the local authority’s science consultant’s previous involvement in CASE professional development. By recruiting teachers from neighbouring institutions, it was anticipated that an additional level of support between schools might be initiated. Third, pre-service science teacher school mentors, teachers studying for a Master’s in Science Education and past pre-service science teachers of King’s College London were invited to participate. Due to their affiliation with King’s, it was anticipated that teachers might want to be involved.

Appendix 6 presents an example of a letter outlining the purpose and requirements of the professional development programme. All potential participants were informed that there were no cost implications and supply and travel costs would be provided.

Appendix 7 presents an example of the information sheet for participating teachers' students concerning the research. Although the focus of this research was on the teacher, the lesson observations were to involve students. Teachers were requested to distribute letters to students that were to be taught using the draft activities observed by the programme tutors.

5.4.1.2 Case study final 'selection'

During the first year of the programme, research data was collected for 12 of the 18 participating teachers. Reasons for non-inclusion of the other six teachers in the initial data collection were: declined the invitation, unreturned research consent forms, and difficulty in scheduling school visits (due to non-replies following email/telephone calls). From the 12 researched teachers, at the end of Year 1, five teachers did not continue on the programme. Reasons for premature departure included: leaving the school to work outside London (two teachers); receiving promotion and having a lack of time; feeling unable to continue without a colleague on the programme; and, feeling over-committed to a number of professional development programmes. Finally, data for one participant was excluded from the study due to an absence of Year 1 observation and interview data.

The resulting participants became the six case studies. Denzin and Lincoln (2008) define this group as a purposive sample – presenting the processes being studied – whereby the processes in this study included: teaching science outside and engagement in a professional development programme. Hence the commonalities between the case studies were that they were secondary science teachers working in Greater London schools with an interest in teaching outside, having completed the two-year 'Thinking Beyond the Classroom' programme, and expressing an interest in being involved in the programme's research. Furthermore, all the case study teachers attended all three Year 1 professional development sessions (see Table 5-3).

Table 5-1 summarises the case study teachers' specialist science subject, general teaching experience, school type, accessibility to outdoor space, previous outdoor experience, method of recruitment to programme and previous relationship with researcher.

Table 5-1 Case study teachers' background information and school contexts

Teacher name* (Science subject taught at A-level)	**School name* and type**	**Access to outdoor space**	**Teaching experience** and additional roles**	**Previous outdoor science experience**	**Relationship with researcher prior to programme (2007)**	**Method of recruitment to programme**
Michael Bison (Physics)	Saviour's Girls' Girls' only Comp. Faith-based	Large school site: including lawn, pond and orchard Local park (2 min walk)	3 years	Taught Y9 Speed distance practicals Taught Y7 ponds (adaption) investigation	None	Colleagues previous involvement in 'London Outdoor Science' project
Cara Brown (Biology)	Nearside College Co educational Comp. Secular	Small concrete playground, with several planted borders. Local park (20 min walk)	7 years i/c KS3 Science	Escorted A-level biology students to FSC residential centre. Participated in London Outdoor Science activity (2006).	Previous involvement in 'London Outdoor Science' project	Department had previously been involved with King's PD training Department had been involved in 'London Outdoor Science' project
Charlie Pence (Biology)	St.Hilda's School Girls' only Comp. Faith-based	School on split site: Small school lawn at one site Local park (10 min walk)	3 years	Escorted A-level class to day-only field centre Taught Y8 ecology sampling methods outside	St. Hilda's is a pre-service partnership school with King's. Involved in PGCE candidate selection.	Ex- King's pre-service teacher. Colleague King's pre-service teacher mentor

Tom Peterson (Chemistry)	Lady Veronica School Girls' Girls' only Comp. Faith-based	Small concrete playground, with several planted borders. Local park (10 min walk)	6 years i/c KS3 Science	'Very little'	None	Colleagues previous involvement in 'London Outdoor Science' project
Megan Thomas (Biology)	St Patricia's School Girls' only Comp. Faith-based	Large school site including lawn and small woodland	5 years i/c KS3 Science i/c student leadership	Escorted A-level students to FSC residential centre. Ecology work with all year groups outside. Use outdoors often as an extension of the classroom e.g. model of digestive system. Breeding trout in classroom and released them in local river.	Completed pre-service placement in researchers' school (2003). Mentor for King's pre-service teachers	Past King's pre-service teacher, current Master's student and pre-service teacher mentor
Claire Westwood (Chemistry)	St.Hilda's School Girls' only Comp. Faith-based	School on split site: Small school lawn at one site Local park (10 min walk)	8 years i/c KS4 Science	'Virtually none' Placing UV beads outside	On the same PGCE course as the researcher (2000-01). Mentor for King's pre-service teachers	Past King's pre-service teacher, current Master's student and pre-service teacher mentor

*Pseudonym; **Number of years experience as of July 2009; Comp = comprehensive; KS = Key Stage 3/4; NB I had been the project officer on London Outdoor Science (see Section 5.4.1)

5.4.2 Data sources

As the research study was situated within the programme of professional development, a flexible approach was required towards the research methods. As will be shown in the following account, this is not to say that methods were not thoroughly considered, however pragmatism was necessary due to the programme's length and anticipated participant attrition. Furthermore, to reduce participant fatigue, the data sources were often carefully constructed to serve two purposes – to develop the programme and to gather research data.

Due to the unique opportunity presented by the programme context, a conventional pilot study was not possible. However, taking an iterative approach, the findings emerging from the data collected during Year 1 informed the refinement of the research instruments for Year 2. For example, interview questions were more specific and frequency counts for lessons were invited in programme evaluations. Table 5-2 presents the range of data sources and the potential frequency for data collection. Due to pragmatic reasons, it was not always possible to collect all data types on all occasions for each case study. Consequently, following the discussion of each of the research instruments, Table 5-3 summarises the specific data sources collected for each case study teacher.

Table 5-2 Research data type and frequency

Data Type	Frequency (Oct 2007 – July 2009)
Session attendance counts	Maximum 6 (3 Year 1; 3 Year 2)
Session field notes	Maximum 6
Session evaluations (Structured questions)	Maximum 6 (3 Year 1; 3 Year 2)
Session reflection sheet	Once (Session 3)
Professional information questions (Structured questions – emailed)	Once
Lesson observations	Maximum 4 (2 Year 1; 2 Year 1)
Lesson interviews (Semi- structured)	Maximum 4 (2 Year 1; 2 Year 2)
STEBI completion	Once (June/July 2009)
Session evaluator's field notes	Maximum 6

5.4.3 Session evaluation

Six professional development sessions took place between September 2007 and June 2009. In Table 5-2 the 'session attendance counts' refer to the total number of sessions attended by the case study participant. At the end of each session, all attendees were asked to complete an evaluation form. Appendix 8 presents an example of the forms used. The purpose of the evaluations was three-fold. First, to ascertain the main outcomes from the session for each participant, requiring teachers to reflect on the session and state what was useful, what was new, and what ideas they would trial in school. Examples of questions were:

> Which part of the day did you find most rewarding? Why?
> Reflect on one idea that you have been struck by today. How can you implement this in your classroom? (Session evaluation, June 2008)

When new activities had been introduced during the session, the evaluation invited participants to rate how confident they were to trial the activity in school – a space was provided for an explanation of their rating. For example,

> On a scale of 0-9 (0 being lowest), how confident do you feel to teach:
> Rose-tinted glasses 0123456789
> Materials 0123456789
> Explain these ratings.
> (Session evaluation, June 2008)

The second purpose was to find out which of the professional development strategies used during the session were considered most and least useful. Whilst this information was used to plan the next session, it also offered an insight into how participants felt towards particular aspects of the session. The third purpose was to establish aspects of pedagogical practice the teacher wanted to develop in future sessions. This information was again instrumental in planning the subsequent session, whilst enabling insight into what participants thought were important areas to be developed to use the outdoors to teach science successfully. An example of a question to elicit this information was:

> Is there anything that you would like from us that would increase your confidence with the project and the activities? (Session evaluation, June 2008).

Two types of question were used in the session evaluations: open-ended and rating scales. Open-ended questions were an attractive choice as the research group was small, so that the range of responses could be relatively easily processed. Cohen *et al.* (2007) note that by using open-ended questions, more opportunities for honest and personal comments are available. Thus, by reducing closed questions, opportunities for extended comments enabled insight into teachers' view of professional development, their expectations, beliefs and teacher efficacy. The drawback of open-ended questions was that they required time on the part of the teacher to reflect and write a comprehensive answer. Therefore a dedicated time was planned into each session allowing for reflection. In addition, as Cohen *et al.* (2007:331) posit 'there is the assumption that all respondents will be sufficiently or equally capable of articulating their thoughts and committing them to paper'. In the case of the six participating teachers, this issue did not seem particularly relevant.

Rating scales were used when new activities had been trialled during a session. Teachers were asked to rate their confidence, rather than their teacher efficacy, as the term was considered more widely understood and less theoretical. However, the word 'confidence', unlike teacher efficacy, was acknowledged as a 'nondescript term that refers to strength of belief but does not necessarily specify what the certainty is about' (Bandura, 1997:382). It was thought that the rating would offer three crude forms of confidence comparisons: individual teacher's confidence levels across different activities; individual teacher's confidence levels over time; and, general teacher confidence levels for individual activities. The scale used was 0-9 with no further information regarding the scale differentials being given to the participants other than '0 being lowest'. Rather than the typical five-point Likert scale, the broader rating scale was used to elicit a degree of detail and precision not gained from a five-point scale, potentially countering the anti-extremist response, where it is reported that respondents prefer not to choose responses at the two extreme poles of the continuum thereby leaving a limited selection (Cohen *et al.,* 2007).

On reflection, by using such a wide continuum and through adding a limited description of the scale categories, it can be argued that one teacher's rating of 1 may be another's 2. This makes an inter-teacher comparison difficult, however it should not affect comparing an individual teacher's response across the range of activities. In addition, space to enable the teacher to justify their score was given. Where participants used this opportunity, an insight into score choice was elicited.

5.4.4 Session field-notes

During each professional development session, field-notes were made concerning participants' responses to strategies. These notes were unstructured and attempted to capture observations of the immediate reactions of teachers during the session. To this end, notes included: questions asked to the tutors, responses to tutors' questions/queries, and, responses to activities inside and outside. Due to the duality of my role, as tutor and researcher, the notes were occasionally not made immediately following an event. Field-notes were also recorded by the programme's internal evaluator (Section 5.4.9 discusses her role).

5.4.5 Lesson observations

The trialling of activities in schools was observed to gain an insight into teachers' interpretation of the programme messages/strategies. Furthermore, lesson observations were used to substantiate what teachers reported during interviews. Lesson observations were set up directly with teachers via email. Teachers identified times, dates, classes and activities usually a fortnight in advance of the visit. The majority of lessons were observed during the summer term – when the majority of trials took place. In the initial correspondence, teachers were asked for some general information regarding their professional history to aid their case study biography (see Appendix 11). Furthermore, to gain an initial insight into the teachers' beliefs concerning learning and science, two open-questions inviting response were emailed: *'How do you think children learn?' and 'Why is science taught in schools?'*

Chapter 4 discussed the pedagogical framework and four principles underpinning the 'Thinking Beyond the Classroom' activities. Table 4-1 presented the principles outlining the associated teaching practices. Appendix 9 offers a more detailed outline for the lesson observations including question prompts to sharpen the observation focus. The time spent on each aspect of the lesson was recorded, with particular attention paid to the amount of time spent outside. In addition to the researcher, the internal project evaluator also used the observation frame. This data was used to develop the case studies and provide 'credibility' (discussed in Section 5.6.2.1). Lesson observations were written-up within 24 hours of the lesson taking place so that additional details were not forgotten.

Alongside written observation notes, video-recording of lessons was trialled. Heath (1997), commenting on the merits of the use of video in data collection, noted that it enables a non-interpretative account, and believes it to be a more accurate process of ascribing utterances to a specific end. As was previously explained, this research was approached from a constructivist epistemology, therefore, viewing the recording was considered to require an interpretation of the material. This outcome therefore negates the merit Heath attributes to the technique. However, it is accepted that a recorded lesson can be accessed by numerous researchers and on numerous occasions, thus enabling a range of interpretations.

Video recording the lessons was trialled on four occasions with limited success. During all of the lessons the sound quality was a problem. Radio-microphones, used in the initial recordings, did not work outside the classroom and gave broken connectivity inside the classroom. The built-in video microphone that enabled recording of whole-class teaching inside and outside, was not sensitive enough to capture individual teacher-student interactions. Although a tripod was used within the classroom, allowing the researcher to continue with the written observation frame, this was not the case outside, where the camera had to be held throughout, thus leaving observation notes to be made later.

A final drawback with using a video-recorder is that it is visible and invasive making teachers feel they are 'on show' which leads them to 'perform' (Heath, 1997). Although it is difficult to substantiate this phenomenon, there was some evidence that when the camera was introduced to the lesson, teachers did 'perform' more and seemed to be less relaxed. Due to the limited number of lessons observed, the time necessary for the teacher to become comfortable with the camera in the room was not available. A decision was made not to use the camera for the rest of the study, however the recordings captured during the initial lessons were not redundant and were used, where appropriate, to substantiate observation lesson notes.

5.4.6 Interviews

As a research tool, the interview is flexible, it can take a number of forms and in doing so can lead to different types of data sources (Creswell, 1998). As this research arose from a constructivist epistemology, the interviews are regarded as an opportunity for interviewees to discuss their interpretation of the world and, more specifically, teaching science outdoors. Viewed from this epistemology, the interview was not considered an ordinary, everyday conversation (Dyer, 1995). Instead a specific objective laid behind the conversation whereby each teacher was viewed as an individual source of knowledge, the knowledge being constructed and filtered through his or her personal belief system (Jones and Carter, 2007). Barker and Johnson (1998) echo this view when they argue that the interview is a medium particularly able to display people's knowledge of cultural forms, indicating how people make sense of their social world and of each other. This perspective was aligned with this study's aim – to elicit teachers' beliefs and teacher efficacy concerning teaching outside.

There is an abundance of interview typologies (Cohen *et al.*, 2007). In an endeavour to enable interviewee knowledge construction around the research aims, the approach taken resembled an 'interview guide approach' (Patton, 1980) or semi-structured interview (Bogdan and Biklen, 1992). Patton (1980) outlines the characteristics of an interview guide approach as a technique where the topics and issues that are to be covered are specified in advance, in an outline form, with the interviewer working through the questions during the course of the interview. Rather than a rigid structure, the interview remains fairly conversational and situational (Patton, 1980). This approach was considered to enable both the researcher and the teacher participant an opportunity to relax whilst enabling systematic data collection. Patton (1980) warns that with increased flexibility, important and salient topics may be inadvertently omitted and comparability between interviewees can become impossible. By interviewing the teachers on several occasions over the course of the two-year programme, this weakness was minimised, as interview questions were returned to, and ambiguous replies probed. Furthermore, this research did not endeavour to explicitly compare teachers' responses to individual questions, but instead replies were used to inform the case studies and to compare and contrast with other data sources.

Interviews were arranged via email (as outlined above) and conducted at the teachers' own school (apart from one telephone interview which took place due to time restrictions). In Year 1, interviews were planned to take place a fortnight following the lesson observation. This timing enabled lesson observation notes to be typed and sent to the teacher prior to the scheduled interview – the intention was that the notes would prompt lesson reflection. However, this procedure only worked in Year 1 for three out of six case study teachers. Gaining access to participant teachers twice in a fortnight was problematic due to their limited availability. Therefore, in Year 2, interviews were scheduled close to the observed lesson, if not immediately following, then at least on the same day. Teachers' did not, therefore, receive observation notes and had less time for post-lesson reflection. The interview responses are therefore more immediate and, perhaps it could be argued, closer to the individual's actual beliefs. On average, interviews lasted 30 minutes; they were audio-taped and transcribed. (See Appendix 10 for the interview questions *aide-memoire*).

As interviews were time-consuming and challenging to organise, to save interview time participants were emailed questions relating to professional experience and views on student learning, science and school science. These 'professional information questions' are presented in Appendix 11.

5.4.7 STEBI

In Chapter 3, quantitative instruments designed to measure teacher efficacy such as the STEBI were described. Although there has been a gradual emergence of qualitative methods to research teacher efficacy, they have often been used to substantiate the findings from quantitative instruments (for example, Czerniak and Schriver (1994) and Palmer (2006)). This thesis wanted to turn this process on its head by using the STEBI-A questionnaire to act as a further data source in constructing the case studies, thereby using the data to substantiate possible emerging findings from lesson observation and interview data concerning teacher efficacy. To use the STEBI in this study, the instrument required modification. This process took time, which led to the STEBI only being administered once at the end of the programme, rather than throughout the two-years.

In January 2009, Riggs and Enoch's (1990) STEBI instrument, including Bleicher's (2004) recommendations for improved validity and reliability (as discussed in Section 3.5), was presented to colleagues at a Science and Technology Education Group research seminar at King's College London for comment and feedback. As the development of a new STEBI reliability assessment was beyond the scope of this research, the discussion sought to find agreement on what further changes were permissible without the need for tool reassessment to narrow the specificity to science teaching outdoors. The concern was that the majority of previous research had used the questionnaire with in-service primary teachers, who are often considered to have low teacher efficacy in science teaching (Palmer, 2006). As a result, the items were concerned with general science teaching and were not concerned with specific aspects of pedagogy that the 'Thinking Beyond the Classroom' programme focused on, for example, the use of practical work, teacher questioning, group work, or the use of the outdoors. Thus, in the seminar, items that easily lent themselves to slight word changes were discussed and agreed. The modified STEBI can be seen in Appendix 12. The following items were changed (numbers in brackets relate to the final STEBI item numbers):

> Item 3 - *Even if I try very hard, I will not teach science as well as I will most subjects* - was removed, as it was felt not relevant to secondary science teachers.

Item 6 (5) was edited to incorporate terminology used more in secondary science classrooms:

from, *I will not be very effective in monitoring science experiments* to, *I am not very effective in organising science enquiry lessons.*

Item 12 (11) was edited to remove elementary and add the outside science teaching:

from, *I understand science concepts well enough to be effective in teaching elementary science* to, *I understand science concepts well enough to be effective in teaching science outside the classroom.*

Item 19 (18) was edited so that a specific skill within science teaching was outlined:

from, *I wonder if I have the necessary skills to teach science* to, *I wonder if I have the necessary skills to teach science outside the classroom.*

Item 21 (20) was edited so that the language was more familiar to teachers in England. The word principal was changed to 'head teacher' in the following item: *Given a choice, I will not invite the principal to evaluate my science teaching.*

All participants were given a paper copy (with a stamped addressed envelope) and sent an electronic copy via email. Five teachers opted to complete and return the questionnaire electronically and one teacher returned it by post.

5.4.8 Reflective diaries

Reflective diaries have been found to afford teachers the opportunity to reflect on their practice whilst offering the researcher an alternative perspective on teachers' thinking (Thorpe, 1994; Alaszewsk, 2006). It was anticipated that by distributing diaries and prompt questions (Appendix 4) to teachers that an alternative perspective might be gained of their beliefs and teacher efficacy concerning the professional development programme and teaching outside. However, during Year 1, only Cara used the diary. As Zimmerman and

Wieder (1977) note, reflection diaries require time and motivation. Bryman (2004:142) suggested that often 'diaries can suffer from a process of attrition, as people decide they have had enough of the task'. It is my view that during session 1, when the diaries were distributed, the rationale presented for teachers to use the diary was not convincing – hence the lack of motivation. On reflection, it was evident that several of Thorpe's (1994) and Alaszewsk's (2006) recommendations for successful diary use were not evident including: being explicit about time periods within which the 'behaviour' was to be recorded; providing a model of a completed section of a diary; and, providing a checklist of items, events or behaviours that jog teachers' memories.

Hence, during session 3, to capture directly specific thoughts concerning one activity taught, a reflection sheet was distributed to all participants with time allocated for completion. The reflection sheet is presented in Appendix 13.

5.4.9 Programme's internal evaluator

During Year 1, funding permitted an internal evaluator to be employed by the 'Thinking Beyond the Classroom' team. Through session and school observations, alongside teacher participant and tutor interviews, the evaluator reported on the outcomes of the programme. The pedagogical framework, discussed in Chapter 4, as well as the observation support sheet (Appendix 9), were shared and used by the evaluator. The data was considered as an additional source, offering a different perspective, and therefore an opportunity for increased trustworthiness (discussed in Section 5.6.2). The internal evaluator's data also informed a report prepared for the programme funders (see Appendix 14). Table 5-3 below presents the data collected for all six case study teachers; the data collected by the internal evaluator is indicated by (I). The following section describes the data analysis.

Table 5-3 Case study participants' data sources

Time	Data type	**Michael Bison**	**Cara Brown**	**Charlie Pence**	**Tom Peterson**	**Megan Thomas**	**Claire Westwood**
Year 1 Oct 2007- July 2008	Session attendance (max. 3)	3	3	3	3	3	3
	Session evaluations	3	2	3	2	3	3
	Professional information questions	Y	Y	Y	Y	Y	Y
	Lesson observations	July	May	May & July (I.)	June	Feb & June (I.)	May & July (I.)
	Interview	July & July (I.)	May & July (I.)	May (via phone)	June	--	May & July (I.)
	Reflective diary	N	Y	N	N	N	N
	Reflective sheet	Y	Y	Y	Y	Y	Y
Year 2 Sep 2008- July 2009	Session attendance (max. 3)	2 (ab. PD6)	0	2 (ab. PD4)	1 (ab. PD 5 &6)	2 (ab. PD6)	2 (ab. PD4)
	Session evaluations	1	0	2	1	2	2
	Lesson observations	July	--	Feb & June	--	July	Mar & May
	Interview	July	July	Mar & June	July	Mar & July	Mar & May
	STEBI	Y	Y	Y	Y	Y	Y

ab.=absent; PD = Professional development session; I.=internal evaluator's data; interviews in person unless otherwise stipulated; each singular occasion of data collection is represented by the month in which it was recorded; Y= Present/completed

5.5 Data analysis

All the interviews were transcribed *verbatim*. The transcripts, alongside, session field-notes, evaluation/reflection sheets, lesson observations and STEBIs were word-processed. Where applicable, episodes during sessions captured in the field-notes were assigned to the corresponding teacher participant. Using the Nvivo software package, the data was sorted and separated for each individual case study teacher. The software package functions for coding and categorising were used, as data was considered easier to manage and store, compared to traditional methods such as paper, pen and highlighters.

This study was designed to explore the relationship between a professional development programme promoting outdoor learning and participating science teachers' beliefs, teacher efficacy and pedagogical practice. To this end, four areas requiring analysis were identified from the study's research questions: teachers' beliefs, teacher efficacy, pedagogical practice and professional development programme strategies. To enable a cross-case comparison, six individual case studies were developed – individual case studies were analysed for each theme.

Focused on an individual case study, the initial analysis involved listening to and reading through all the teachers' data, on multiple occasions, over several days, in an attempt to become immersed in their experiences. The data sources for individual case study teachers were used in combination and at different stages of the analysis. For example, interviews and lesson observations were often used initially to gain an oversight or 'sense' of the teachers' beliefs and later evaluations, the reflection sheet and field-notes were used to strengthen (or question) the interpretation. That said, for each of the four areas (teachers' beliefs, teacher efficacy, pedagogical practice and professional development strategies) some sources of data were more pertinent to the analysis – for example in analysing pedagogical practice, the principal data source was lesson observations. The data analysis procedures are set out further below.

Although data pertaining to participating teachers were initially analysed separately for individual themes, the latter stages of the case study production were considered iterative. That is to say, when new codes or categories emerged for particular research areas, earlier case studies were returned to and re-analysed. As Bryman (2004:444) comments, 'we cannot understand a given case without knowing about other cases'. The case studies were considered both a process of inquiry and the product of the inquiry. Chapter 6 presents a condensed version of the case studies' 'stories'.

Answers to the questions that had been emailed to participants enquiring into their previous professional experiences informed the background section for each case study (see Chapter 6 for case study background and Appendix 11 for professional information questions). Table 6-1 presents the frequency and range of activities trialled by the participants. This information was provided through session 6's evaluation and by the Year 2 interviews. Furthermore, information concerning the case study teachers' school contexts were retrieved from school websites, Ofsted reports and during school visits. Where Ofsted reports were used, to preserve anonymity, references to the school name were omitted.

5.5.1 Developing analysis schemas

Reflecting the study's epistemology, constructivist grounded theory methods were used in the data analysis (see Charmaz (2010) for an in-depth discussion concerning traditional grounded theory and constructivist grounded theory). Put simply, where traditional grounded theory is positioned as objective in its search for truth (Glaser, 1992), a constructivist grounded theory approach recognises 'that the categories, concepts, and theoretical level of an analysis emerge from the researchers' interactions within the field and the questions about the data' (Charmaz, 2010:196). Hence, rather than *the* truth, the constructivist approach accepts that the story told by the analysis reflects the viewer as well as the viewed (*ibid.*).

Drawing on Lincoln and Guba's (1985) approach, following an initial coding of each individual case study participant's data for a particular research area – for example, teacher beliefs – the codes were grouped into categories based on similarities. As noted above, this process was iterative, that is as new codes and categorises emerged, previous data and case studies were returned to and re-examined. Notwithstanding, from a constructivist grounded approach it was acknowledged that the role of the researcher, as well as the research context, influenced the emerging findings. As the research was a response to a professional development programme, predetermined pedagogical intentions and pre-designed strategies were more germane to the research focus than others. Chapter 4 discussed the 'Thinking Beyond the Classroom' programme aims and theoretical frameworks. Consequently incidents that corresponded to the pedagogical principles or programme strategies were more in focus and the coding schemas reflect this point. However the constructivist grounded approach, rather than acting as a predetermined analytical framework, ensured that emerging/new codes/categories were not ignored. Furthermore, knowledge of relevant research literature was considered a positive analytical strategy that enabled the recognition of omissions from the data. The analytical process used for each research area is discussed below.

5.5.2 Analysis of teachers' beliefs

As discussed in Chapter 3, beliefs are considered 'personal constructs [...] non-evidential as they are based on personal judgements and evaluations' (Luft *et al.,* 2003:1-2). The importance of the concept of beliefs to this study relates to the relationship with behaviours (Rokeach, 1968; Ajken, 1998); Or, more specifically, of teachers' beliefs – their relationship with pedagogical decisions and practice (Pajares, 1992). Research question 1 of this study asks: *what is the interplay between teacher beliefs [...] and pedagogical practice?* To this end, teacher participant beliefs required identification.

It is accepted that identifying beliefs is challenging as they have to be inferred from what is said and observed – and may remain hidden (Hodson, 1993). This study was concerned with science teachers' beliefs related to teaching outside, alongside other elements of the professional development programme, creating the focus of the analysis. However, through the use of grounded theory methods, I remained open to emerging themes – as was previously set out above.

Due to the nature of beliefs, the data sources analysed for each case study teacher included: interviews; session evaluations; professional information questions; lesson observations; and, the reflection sheet (see Table 5-2). At the broadest level, five categories of beliefs were identified: beliefs related to pedagogical practice – for example, the purpose of questioning and group work; beliefs related to outdoor learning – for example, the teacher's role outside and how learning should be managed; beliefs related to teaching and learning – for example, how students learn; beliefs related to science and school science – for example, what should be taught about science; and, beliefs related to professional development and the 'Thinking Beyond the Classroom' programme – for example, the purpose of professional development. Categories were identified as overlapping. Appendix 15 presents examples of the emerging codes for teacher beliefs.

The resulting analysis informed the six case studies presented in Chapter 6. In addition, Table 6-2 presents a summary of the case study teachers' beliefs and enables a cross-case comparison. Furthermore, as the aim of the programme was to influence pedagogical practice, it was anticipated that teacher beliefs might change over the programme. Hence, the case study teachers' beliefs were analysed both for Year 1 and for Year 2 (Appendix 21).

To clarify how beliefs were coded across data sources, two examples are provided. Further exemplifications of the interpretation of teacher beliefs are presented for each case study in Chapter 6. In an interview, case study teacher Michael is asked whether he felt any of the lesson taught inside could have been taught outside. He responded:

> Well, we could have, like for example, the one today could have started off outside, and there are some benches outside, and we could sit around the bench out there, it was very simple activity, just looking at the different pictures and then trying to establish what the different habitats were. The other ones, the glasses ones, I think the science in there is a bit too complicated to really explain it outside, so it's much more useful to have some PowerPoint slides, where you can just show them the primary colours, and then have a mix, and then… or show them a prism. There are some things that you could do outside, but they are just easier to do inside and you can get them done in a shorter period of time. (Michael, Interview, July 2009)

Two belief categories were identified in the extract: *beliefs related to the outdoors* and *beliefs related to learning/teaching*. For the former category, when Michael says 'I think the science in there is a bit too complicated to really explain it outside', the belief inferred was that 'learning science outside is more challenging than in the classroom'. For the latter category, when Michael says ' […] much more useful to have some PowerPoint slides, where you can just show them the primary colours, and then have a mix […]' the belief inferred was that 'students learn when told'.

A second example came when Cara, completing the reflection sheet during session 3, responded to the question, *What skills do you plan to further develop/focus on through the next activity you teach?* by writing:

> Group work – getting all to contribute equally
> (Cara, Reflection sheet, June 2008)

The belief category identified was *beliefs relating to pedagogical practice,* and more specifically to the purpose of group work. Cara's inferred belief was that 'effective group work should provide students the opportunity to equally contribute to a task'. Whilst illustrating how beliefs were identified across two sources – interviews and reflection sheets – the examples above illuminate the difficulty of interpreting beliefs; hence the use of multiple sources to substantiate claims.

5.5.3 Analysis of teacher efficacy

Teacher efficacy has been defined as a teachers' judgment of their ability to influence student learning (Bandura, 1977). Teacher efficacy therefore influences the decisions that teachers make – evident in both what they say and in their pedagogical practice (for example, Bandura, 1977; Cantrell and Callaway, 2008). Research question 1 sought to understand the relationship further by asking: *What is the interplay between […], teacher efficacy and pedagogical practice?*

As with teacher beliefs, the construct 'teacher efficacy' is not easily identifiable. Chapter 3 highlighted that quantitative instruments, often requiring teachers to explicitly judge their future abilities, have dominated research into teacher efficacy. These measures are informative, however, I argue that due to a number of reasons, for example, the researcher-teacher relationship, participants might not always express how they honestly feel in words or through a research instrument. I propose that teacher efficacy may be inferred through actions or indirect comments. To this end, teacher efficacy has been analysed in this study in two forms – put simply, explicit teacher efficacy and inferred teacher efficacy. The first type of teacher efficacy was informed by teachers' ratings of themselves through two different instruments and the identification of explicit statements concerning future ability concerning teaching. The second type, referred to as Researcher's Perception of Teacher Efficacy (RPTE), required the development of an analytical framework based on previous research studies. Methods of analysis for both teacher efficacy and RPTE are discussed below.

5.5.3.1 Analysis of teacher efficacy

The case study teachers' explicit teacher efficacy was interpreted from two quantitative research instruments and through explicit statements concerning future abilities. The first instrument was incorporated into the session evaluation and asked the participant to rate their confidence to teach the new activities introduced during the session. For example:

> On a scale of 0 – 9 (0 being lowest), how confident do you feel to teach:
>
> 1. Starter (egg box) activity 0 1 2 3 4 5 6 7 8 9
> 2. Forces around us: Invisible/visible 0 1 2 3 4 5 6 7 8 9
> 3. Back to the Sun 0 1 2 3 4 5 6 7 8 9
> 4. Turning over a new leaf 0 1 2 3 4 5 6 7 8 9
>
> (Session evaluation, Nov 2007)

The case study teachers' ratings were compiled and average ratings were worked out for individual case study teachers and for individual activities. Appendix 16 presents the teachers' confidence ratings. Overall, the data indicated little variation between the case study teachers in terms of their rated confidence. That is, mean responses ranged from 6.2-7.2 – the mode was 7. However the analysis provided some indication of particular activities that all case study teachers felt more/less able to teach. For example, the Air Pollution activity was rated on average 5.2, which was comparatively low. These findings were useful for research question 2 that asks: What professional development strategies are significant in influencing teachers' practice?

A concern, however, was the trustworthiness of the instrument as occasional disparities were evident between the confidence ratings and the interview data. For example, Charlie rated his confidence as '7' to teach the Materials activity; however in a later interview he confided having felt initially under-confident following the session resulting in him not trialling the activity. Possible reasons for this disparity include: ratings were assigned context-free – there was no specificity concerning the type/level of classes (as noted earlier); and, the ratings were assigned immediately following the session allowing little time for reflection or for thorough reading of activity notes. Section 5.6.2, below, considers the trustworthiness of the research methods further.

The second instrument analysed explicitly for case study teachers' teacher efficacy was the STEBI. As noted above, the STEBI was developed to capture science teachers' teacher efficacy as a quantitative score (Riggs and Enoch, 1990). Following Riggs and Enoch's (1990) analytical methods, each STEBI item was identified as determining either: Personal Science Teaching Efficacy dimension (PSTE) or Science Teaching Outcome Expectancy dimension (STOE) (this follows Bandura's original thesis that teacher efficacy is a compound variable – see Chapter 3 for a further explanation). An example of a PSTE item was: 'I am continually finding better ways to teach science'. An example of a STOE item was: 'When a student does better than usual in science, it is often because the teacher exerted a little extra effort' (*ibid*.:634).

Following Riggs and Enoch's format, scores were assigned to the case study teachers' rating on the five-point Likert scale. Five was assigned to a positively phrased item that received 'strongly agree', a score of four to 'agree' and so on. Conversely negatively worded items were scored in the opposite direction with 'strongly agree' receiving a score of one. Item scores for each dimension were aggregated for individual case study teachers. Appendix 17 presents the case study teachers' STEBI scores.

The STEBI data, which was only collected on one occasion – towards the end of the programme – offered the study limited insight regarding teacher efficacy change over the two-years. That said, all the case study teachers received a high score for PTSE – the range was 51-58 (from a possible score of 60). STOE scores were not as high, ranging between 34-42 (from a possible score of 60). This finding, that STOE scores were lower than PTSE scores, was consistent with other studies (where teachers were considered to have high teacher efficacy), leading researchers to suggest that the STOE dimension was less reliable than the PTSE dimension (Gibson and Dembo, 1984). Furthermore, it has been acknowledged that STOE items are very open to interpretation and responses are very dependent on the teaching context (Riggs and Enoch, 1990).

Finally case study interviews were analysed for explicit statements concerning confidence. These were limited, however examples included:

> I felt very wary about going from inside to outside
> (Cara, Interview, June 2008)
>
> You feel that much more confidence – oh that's what you do, oh that's easy I can do that – and then you start and get better and better.
> (Megan, Interview, April 2009)

5.5.3.2 Researcher perception of teacher efficacy

Teacher efficacy is a *personal* judgement concerning an anticipated future. Often, however, indirect comments and actions may offer an insight into the non-verbalised self, a self that might not be made explicit to the researcher for multiple reasons (discussed below). Hence, not intending to undermine or replace explicit teacher efficacy, this study developed the Researcher's Perception of Teacher Efficacy (RPTE) guide, to analyse utterances and behaviour for inferred teacher efficacy. By developing such a guide, alongside explicit teacher efficacy analysis, it was anticipated that greater credibility in the findings might be achieved.

Chapter 3, informed by the literature, presented a list of pedagogical traits of teachers identified as having high teacher efficacy (see Section 3.4.2). The traits were organised along five dimensions: subject knowledge, flexibility, teacher/learner focus, behaviour management and disposition. Using these dimensions, a guide was developed describing the pedagogical practice of teachers with high and low teacher efficacy. The assumption was that teacher efficacy might be identified from pedagogical practice – ranging between, and beyond, the guide's polarised descriptions. As teacher efficacy is task specific, a description is presented for a teacher considered to have high teacher efficacy implementing the pedagogy from the professional development programme. Possible behaviours and attributes are included from both inside and outside the classroom.

Table 5-4 below, presents the RPTE guide. To use the guide, rich written descriptions of case study teachers' pedagogical practice for Year 1 and 2 were required. Each was compared to the RPTE guide – and an interpretation of teacher efficacy was given. Chapter 6 presents the findings in the case studies.

Table 5-4 Researcher's Perception of Teacher Efficacy framework

Dimension	High teacher efficacy traits	Low teacher efficacy traits	Possible behaviours and attributes for a teacher with high teacher efficacy involved in the professional development programme
Subject knowledge	High level of subject knowledge that affords a high frequency of real-life examples to be used. Open-ended questions used.	Low level of subject knowledge that affords a low frequency of real-life examples to be used. Limited closed range of questions used.	Attempts a range of activities across all science areas. Uses open-questions to enable cognitive challenge. Incorporates examples from the surrounding environment into explanations and encourages learners to do similarly. They are able to do this both inside and outside the classroom.
Flexibility	Willingness to experiment with new ideas and increase pedagogical methods.	Unwilling to try new ideas or take risks in pedagogical choices.	Attends and is engaged in all sessions. Attempts multiple activities with a range of year groups/ abilities*. Observed explicitly teaching observation and group work skills. Able to transfer classroom pedagogy and develop new teaching methods to the outdoors. Finds unique opportunities for teaching outside. Looks for opportunities within other areas to incorporate ideas from the programme.
Teacher/ learner focus	Focus is on learners and learning; uncritical and supportive of students.	Focus is on teacher/ teaching (on 'product' and 'having fun'); may be critical of students.	Plans lesson from student perspective. Group work has included thoughtful designs of group members. Involves students in decisions, including constructing investigation questions. Time allocated for student reflection on their learning. Students encouraged to give feedback to other students. Students are given ownership of their own learning both in and outside the classroom.
Behaviour Management	Pedagogical choice dictates behaviour management techniques.	Behaviour management dictates pedagogical choice.	Plans lessons on how best to engage students and provide cognitive challenge. Will plan behaviour management strategies into activities. Both in and outside students are encouraged to recall their own group 'rules' to foster good working relationships. Consideration of how the outdoor space will be used for learning, including sites for whole

			class and group teaching.
Disposition	Enthusiastic	Apathetic	Discusses planning with other colleagues. Disseminates programme outcomes with whole department. Adapts activity plans for specific contexts. Sees opportunities and solutions to the outdoors. Is realistic.

*Table 6-1 presents the range and frequency of lessons trialled by case study teachers.

5.5.4 Analysis of pedagogical practice

All three research questions required the analysis of participating teachers' pedagogical practice. The analysis was completed separately for Year 1 and 2 as research question 3 required a consideration of the potential change in practice: How do teachers' beliefs and teacher efficacy influence responses to professional development programme strategies identified as significant in changing practice? For this area of research, lesson observations provided the main data source. However, interview data was used to substantiate findings. Interview questions initiating insightful responses included:

> How do you feel the lesson went?
> What were the lesson objectives? Were they achieved?
> Why did you choose to do *[insert]* and *[insert]* in the lesson?
> What planning was required to teach the activity?
> How did the group work/questioning go?
> How do you feel your skills developed within this area over the project? Can you give me any examples of this?
> How did these activities differ when outside the classroom?
> (See Appendix 10 for interview questions *aide-memoire*)

Data was initially analysed for evidence of the four principles underpinning the 'Thinking Beyond the Classroom' programme. The programme's pedagogical framework was described in detail in Chapter 4 and Table 4-1 outlined the pedagogical practice characteristics for each principle. Initially, these characteristics guided the analysis. That said, the analysis was open to other emerging codes/categories (for example, management of student learning outside), to inform the resulting case studies in Chapter 6. Appendix 20 presents examples of codes for pedagogical practice.

To enable simple cross-year and cross-case comparison, the case study teachers' practice was initially categorised as 'outstanding' through to 'satisfactory'. On reflection, following discussions with my supervisors, it was felt such terms could be misinterpreted for Ofsted inspection grades of teachers' practice. Hence, as the judgement of practice was principally on the implementation of the programme activities – and the principles of the pedagogical framework – teachers' practice was categorised as *very successful* implementation of the programme activities through to *less successful* implementation. However, it is stressed that practices which were not necessarily included within the original pedagogical framework, such as managing student learning outside, but which were subsequently identified as important to teaching science outside, were also considered in the categorisation. Table 6-2 presents the assigned categories to case study teachers for professional development implementation.

5.5.5 Analysis of professional development programme strategies/factors

Research questions 2 and 3 required the identification of programme strategies and factors considered significant in influencing the case study teachers' beliefs, teacher efficacy and pedagogical practice. In Chapter 4 the planned strategies used in the 'Thinking Beyond the Classroom' programme were identified and separated into three groups: those occurring during the sessions, those occurring in school and those as occurring in 'other-settings' (see Table 4-5 for planned strategies).

The lists of strategies across locations were initially used to analyse the data and they were altered when new categories emerged or sub-categories were identified. The advantage of having a list of pre-identified strategies was that any omitted strategies could be recognised. It emerged that untangling a professional development strategy from a pedagogical principle was frequently quite difficult, as the significance of the strategy required a context. Hence, session strategies were separated into 'general strategies' and 'strategies related to pedagogical principles'. An example of the former was, 'an activity developed within a group' and of the latter, 'an activity to identify cognitive challenge in the lessons through group discussion'. Appendix 18 presents all the strategies identified. For individual case studies the significance of the strategy is discussed.

All data sources were used to identify the programme strategies/factors. For example, interview questions eliciting insight of strategies included:

> What do you see professional development as?
> What were your impressions of the sessions?
> How does the programme compared with other professional development courses?
> What determined the choice of the activity that you have trailed?
> Do you feel like participating in the programme has influenced you or your teaching in any way? Why did you continue in the project?
> Did working with a colleague on the project bring any benefits? If so what?
> Did you feel supported by your department / school with being involved? What is your school policy for professional development?
> (Appendix 10, Interview questions)

Furthermore the session evaluations offered insight into immediate responses to session strategies by asking:

> Q4 Reflect on one idea that you have been struck by today. How can you implement this in your classroom? (Session evaluation, June 2009)

Lesson observations were used to substantiate claims made from other data sources by looking for evidence of the practice that the strategy was attempting to encourage/develop. Furthermore, evidence of the strategy's influence was occasionally evident in observed lessons having not been explicitly acknowledged. For example, teachers were observed to use strategies for managing learning outside which were similar to those trialled during the sessions.

Finally, using Bandura's (1997) theory of self-efficacy construction, strategies were categorised as potential sources of teacher efficacy (as discussed in Chapter 3). That is, strategies were considered as providing potential opportunities for: cognitive mastery, enactive mastery, verbal/social persuasion, vicarious experiences and emotional/psychological experiences. To categorise the strategies, the case study interviews were returned to, or the session field-notes, and the context within which the strategy was discussed or took place was considered. For example, if the teachers discussed trialling an activity during a session as being influential, the field-notes were consulted to establish the type of strategy and potential teacher efficacy source. Appendix 26 presents the strategies with the assigned potential teacher efficacy sources. Influential strategies are discussed within the case studies in Chapter 6; Chapter 8 discusses cross-case findings.

5.6 Reflections on the methodology and methods

5.6.1 Ethical considerations

Tobin (1992) describes circumstances in which an ethical dilemma might occur as one in which a 'researcher encounters a situation in which he or she is not sure how to act to protect and promote the interests of all participants in the study' (p.113). In a bid to reduce the ethical dilemmas met in this study, BERA's (2004) and King's College London's ethical guidelines were consulted and appropriate procedures were followed to ensure a duty of care. This research was ethically approved by King's College London initially one year with approval sought, and received, in Year 2 (reference number (EM)/07/08-38)).

Cohen *at al.* (2007) asserts that the bedrock of ethical procedures is *informed consent*. Following the recruitment of teachers to the 'Thinking Beyond the Classroom' programme, all teachers were invited to participate in the research study. To this end, information was provided offering an overview of the research aims, methods – including the possibility of filming lessons – and implications (Appendix 19). Anonymity was assured with the use of pseudonyms. Teachers volunteering to be involved in the study were asked to sign a consent form and retain a copy of the information sheet and a second consent form. Participant teachers were made aware of their right to withdraw from the study, as well as their right to withdraw their data, until July 2009. It was stressed that their decisions to participate in the study did not affect their continued involvement in the programme.

When lessons were to be observed – and video-recorded – parental/guardian and student consent was sought (see Appendix 7 for an example of the consent form); participating teachers collected the student consent forms returning them to the researcher. The teacher interviews were recorded and at the start of each interview confidentiality was reiterated. However due to time constraints, interview transcripts were not sent to participants for comment.

Although the procedures above reduced the ethical dilemmas, they did not eradicate ethical concerns. As Cohen *et al.* (2007) note, concerns requiring consideration to ensure the interests of the researched are served include: where does formal observation and informal observation begin? And is it justifiable to be open with some teachers and closed with others? Two ethical concerns particularly pertinent to this study were the dual role of the researcher/tutor and the researcher's former relationships with participants. Section 5.6.4 sets out my role and research perspective and Table 5-1 outlined former relationships with the teacher participants. Two research dilemmas concerning the duality of my role with research participants are discussed below.

The first issue was the research interview. Section 9.4.2 discusses the finding that the research interview was an occasional professional development strategy. This was both methodologically and ethically problematic – highlighting the difficult and compromising role I had as researcher and tutor. However, the duality of the role offered insights potentially not afforded to a 'detached' researcher – as for example, the teachers developed trust in me when discussing the effectiveness of the programme's activities. Hence, to maintain these relationships, and to ensure that the teachers' interests were central, when required, a reversal of role to tutor from researcher was permitted. That is to say, if the teachers asked for guidance or my opinion during an interview then I responded rather than ignoring the question, returning to the role of researcher as appropriate.

The second ethical issue is similarly related to maintaining participant trust both during and following the data collection/professional development programme. Decisions were required as to the type and quantity of, and the frequency with which, research data were shared with participants. In doing so, I continually reflected on the aim and anticipated outcome of the process – wanting to both protect and promote the interests of all participants in the study, whilst offering a breadth of insights across a variety of teachers' experiences (Tobin, 1992).

Hence, as discussed earlier in Section 5.4.6, during Year 1 I shared with all the teachers the lessons observations to prompt reflection prior to the interviews. The lesson observations were mainly descriptive, responding to the shared pedagogical framework and lesson pillars discussed during the programme sessions (see Appendix 9). Perhaps due to their purely descriptive nature, the observations received minimal response from the teachers.

Following the programme, in an attempt to bring further credibility to the study, I shared the case studies with the teachers (as discussed in Section 5.6.2.1). Rather than give all six teachers their case study, I chose to share the texts with only three. What prompted this approach was the research dilemma that whilst wanting to include the particular and individual differences between the teachers, so that the research issues might be better understood, I wanted to avoid communicating a negative impression to the teachers either personally or professionally, something which might have been a consequence.

Returning to Tobin's (1992) observation above, I accept that this research decision is not entirely satisfactory but rather a calculated compromise. So although the identity of the teachers has been protected by the use of pseudonyms, preventing others from recognising them, that tactic would not stop the teachers from recognising themselves if they were to come to the text independently. As such, this approach reflects a necessary compromise given the relevance of the observations made to the insights emerging from the study.

5.6.2 Trustworthiness

Reflecting on the study's epistemology and related 'truth value', the term 'trustworthiness' was considered more appropriate than 'reliability and validity'. Although much commonality is shared between the terms, Lincoln and Guba (1985) proposed that reliability and validity originated from a positivist paradigm, whereas trustworthiness was rooted in a constructivist paradigm. Hence, at the core of claims concerning reliability and validity 'there is an assumption of a single, tangible reality that an investigation is intended to unearth and display' (*ibid.*: 294). Whereas for the constructivist researcher – with an acceptance of multiple constructions – trustworthiness was concerned with demonstrating:

> […] that the *reconstructions* that have been arrived at via the inquiry are *credible to the constructors of the original multiple realities*. (*ibid.*:296; italics in original)

To this end, as the intention of this study was to illuminate findings that are sufficiently authentic, Lincoln and Guba's (1985), and more recently Denzin and Lincoln's (2008) trustworthiness criteria were considered an appropriate framework to guide this study. The four criteria of trustworthiness are: credibility, transferability, dependability and confirmability.

5.6.2.1 Credibility

Credibility relates to confidence in the findings and concerns ensuring that the study is carried out to enhance its credibility and 'demonstrating the credibility of the findings by having them approved by the constructors of the multiple realities being studied' (Lincoln and Guba, 1985:296). To achieve these goals five techniques were implemented.

The first technique involved the data being collected over an extended period of time (two-years). Maxwell (2010) notes that not only does this provide more, and different kinds of data, the data can be cross-referenced and is less dependent on inference. Furthermore, replications of incidents could be identified – enabling the recognition of themes – as well as isolated incidents. Collecting data over an extended period also enabled the methods to be refined (such as lesson observation methods) and inferences to be investigated – for example through follow-up interview questions. The second related technique to enable credibility was the collection of 'rich data' for the construction of the case studies that was enabled through: long-term involvement, extended and multiple interviews, and for two case study teachers within the same school – Claire and Charlie – contextual cross-case analysis (for example, descriptions of departmental contexts). Becker (1970) described 'rich data' as that which is detailed and varied enough to provide a full and revealing picture of what is going on.

The third technique involved using a range of data sources including: interviews, lesson observations, field-notes, session evaluations and the STEBI, which enabled a range of 'observations' from different perspectives to be made. By using this technique, claims could be substantiated and omissions between data sources identified (Denzin and Lincoln, 2008). The fourth technique used to enhance credibility was the use of external checks on the study's process. This technique involved both colleagues and my supervisors. For example, on two occasions at an internal research meeting, research themes emerging from my data were discussed. Guba and Lincoln postulate that external checks 'keep the inquirer honest' enabling them to be 'fully aware of their posture and position' (1985:302). However I acknowledge that researcher bias is unavoidable, and is required to be made explicit. Section 5.6.4 below sets out my research perspective.

Finally 'respondent validation' (Bryman, 2004) or member checks (Lincoln and Guba, 1985) were solicited from the case study teachers regarding the data and the case studies constructed. That is, in Year 1 study participants were emailed lesson observations following the lesson and asked for comments concerning the notes during the follow-up interviews (discussed in Section 5.4.6). Furthermore, three participant teachers were invited to comment on their completed individual case studies – Megan, Claire and Charlie. Neither technique provided new insights – in general, participants commented that there had been no time to read the lesson observations and the completed case study accounts were acknowledged as 'fine'. Noteworthy was the decision to invite only three of the six participants to read their constructed case study. This was due to the sensitivity of the material. That is, I was concerned that three of the case study accounts might communicate a negative impression, which was not the intention of the research (or the programme) and was something I felt should be avoided. On reflection, as Maxwell (2010), citing Hammersley and Atkinson (1995), comments, feedback from member checks although important, are no more inherently valid than the original interview responses – both acting as *evidence* regarding the validity of the researcher's account.

5.6.2.2 Transferability

If credibility were considered a substitute for internal validity, transferability might be a substitute for external validity (Lincoln and Guba, 1985). However, rather than being concerned with the generalizability of the study's findings – which has already been asserted does not concern this study – transferability refers to the 'availability' of the data. That is, transferability of the findings requires a rich description of the research contexts, methods and data analysis. That said, as Lincoln and Guba acknowledge, 'the burden of proof lies less with the original investigator than (with) the person seeking to make an application elsewhere' (1985: 298). Hence the study has presented rich details – including supplementary information as appendices.

5.6.3 Dependability and confirmability

Dependability refers to the consistency, predictability, stability or accuracy of the research findings (Lincoln and Guba, 1985). Dependability within this study is difficult to account for as it was anticipated that participant behaviours (pedagogical practice) and viewpoints (beliefs and teacher efficacy) would change – depending on the circumstances. Furthermore, as earlier acknowledged, if another researcher were to repeat this study, using identical methods and teacher participants, they might not come to the same conclusions. That said, the dependability was felt to be enhanced through data collection by the internal evaluator (discussed in Section 5.4.9). During Year 1, the three interviews and three lesson observations that the internal evaluator completed enabled intra-data checks to be undertaken. For example, lessons observations of the researcher and internal evaluator were compared to identify any discrepancies between reported pedagogical practices. Rich descriptions of the research are provided offering an insight into the accuracy of the findings. Furthermore, an audit trail was maintained which is discussed below as a technique used to support the final trustworthiness criteria, ‘confirmability’.

Confirmability is concerned with the degree to which the findings of an enquiry are determined by the focus of the study and not the researcher’s bias (Lincoln and Guba, 1985). Hence an audit trail was maintained to capture methodological and analytical decisions made over the course of the study. The trail consisted of written records, diagrams and flow-charts which alongside my own decisions, included meeting records with both my supervisors. However, some researcher bias was inevitable – hence the following section discusses the researcher’s perspective.

5.6.4 Researcher’s role and perspective

My role, and the relationship I had towards the study context, was not simply one of objective ‘faceless’ researcher (Fontana and Frey, 2000). In this study, I was both a tutor and the programme coordinator, requiring the co-authorship of the activities, the development and running of the sessions, and general administration duties, including reporting to the programme steering committee and funders (the AstraZeneca Science Teaching Trust). To the participating teachers, in addition to the above, I was the researcher. To add to this complexity of research objectivity, previous relationships have been held with several of the participant teachers under different circumstances (see Table 5-1) and reported in the individual case studies (Chapter 6).

My own professional history informs not only the study’s professional development programme but also my own research perspective. Completing a degree in Environmental Science, which lent itself to outdoor learning, and working for the Field Studies Council, as an assistant tutor and project officer, I have first-hand experience of the affordances of learning that being outside offers, in addition to the concomitant limitations. In parallel there has been my education in science education. Initiated by a PGCE from King’s College London, I spent five years working as a secondary school science teacher and school-based PGCE mentor in inner London, whilst completing a Masters degree in science education at the same institution. My beliefs concerning how learners learn science, and how teachers might teach, are heavily influenced by my experiences at King's. In highlighting my educational foregrounding, I reveal the roots of the pedagogical framework presented in Chapter 4. In constructing this pedagogical framework, my past and present academic research from King's can be seen to dominate much of my understanding. Therefore, it is acknowledged that my relationships with the researched, my advocacy for teaching science outside, and my own understanding of how children learn science will shape this research study. However, these aspects do not prevent me from carrying out this study. Eisner (1991) postulates that the self is the instrument that enters the research situation and makes sense of it, a position seen reflected in this study's constructivist methodology. In acknowledging my frames of references (Erickson, 1986), I was able to become more reflexive and reflective when planning, conducting, analysing and representing the research.

5.7 Chapter summary

This chapter has described the methodology used in the research alongside the methods used to collect and analyse the data to address the research questions. A range of data sources were used to provide multiple perspectives of the research participants' view-points (beliefs and teacher efficacy) and pedagogical practices and the influence of professional development strategies. Methods from which data was successfully sourced included – interviews, lesson observations and field-notes – and whilst reflective diaries were trialled, participants' use of them was limited. Whilst the majority of methods were used throughout the duration of the study, the STEBI questionnaire was only administered on one occasion, and although limited in this study, the adapted research tool might be useful in future research studies.

The data sources were analysed for four research areas – teachers' beliefs, teacher efficacy, pedagogical practice and professional development strategies/factors. Data from some sources were noted as more pertinent for some areas – but all sources were used, where appropriate, to substantiate findings. Whilst the analysis was approached with openness to emerging categories/codes, it was acknowledged that the research literature, as well as the programme context, was influential.

Chapter 6 Teacher Participant Case Studies

6.1 Introduction

Huberman and Miles assert that the case study enables the researcher 'to become intimately familiar with each case as a stand-alone entity', suggesting that their creation 'allows the unique patterns of each case to emerge' (2002: 17-18). To this end, as explained in Chapter 5, six *instrumental* case studies were developed – requiring rich descriptions – offering insight into phenomena and potential theory development.

This chapter presents six separate case studies for science teachers completing the two-year professional development programme – 'Thinking Beyond the Classroom'. By way of background, a brief professional biography is given including the teachers' experience of CASE and AfL, and the school context (including access to outside space) where the activities were trialled. Chapter 5 set out the four areas that were this study's focus: beliefs, teacher efficacy, implementation of programme activities and influential professional development strategies. These research areas structure each case study.

As the entire study took place over two years, during the professional development programme's duration, changes in beliefs, teacher efficacy and practice were evident and are reported. Teacher efficacy, when discussed, refers to both explicit teacher efficacy and researcher's perception of teacher efficacy (RPTE) when both are found in agreement. However, where conflicting teacher efficacy levels were identified, a distinction is made between explicit teacher efficacy and RPTE outcomes. To substantiate and justify the teacher efficacy judgement, data analysed using the RPTE framework are presented. The five dimensions of the framework were: subject knowledge, flexibility, teacher/learner focus, behaviour management and disposition. Furthermore, when considering each teacher's implementation of the programme, the principles of the pedagogical framework are discussed.

In presenting the case studies, a fine balance was required to ensure rich descriptions were not repetitive or superfluous. Also space was limited due to the number of case studies. Initially I considered presenting two contrasting cases in great depth, offering an insight into the analytical journey and presenting vast amounts of substantiating data, followed by four comparatively brief case studies. However, although great variations between case studies were of concern, this study was more interested in the subtle differences between teachers' beliefs and teacher efficacy and their influence on practice. Hence, all six cases studies are of equal depth. However to offer a greater insight of the RPTE analysis the first three case studies include exemplification for each dimension, compared to the condensed descriptions for the latter cases. Where exemplification was omitted for a particular feature – for example, a specific belief – that data, where required, is presented in Chapters 7 and 8. That said Claire and Michael's case studies are presented first to reflect contrasting pedagogical practice related to the programme implementation - setting the parameters for the subsequent cases. Although the case studies 'stand alone', occasional comparisons are made in the chapter between teachers, providing a point of reference. Furthermore, the degree of teachers' implementation of the programme's pedagogical framework is compared and is captured in descriptions such as 'successful' and 'unsuccessful'. Appendix 21 presents a summary of the case study teachers' beliefs, teacher efficacy, programme implementation and significant professional development strategies. Table 6-1 presents data used to inform the case studies including the frequency and year groups that activities were trialled over the programme's duration.

Table 6-1 Case study teachers' activity range and frequency

	Michael Bison	**Cara Brown**	**Charlie Pence**	**Megan Thomas**	**Tom Peterson**	**Claire Westwood**
Total number of activities trialled	9	8	14	25+	7	15
Number of different activities trialled (Max. 10)	4	4	6	10	4	7
Year group activity trialled	7-9	8, 9	7, 9,10	7-13	7-9	7-10

(Sources: Field notes, session evaluations/reflections and interviews)

6.2 Case: Claire Westwood

6.2.1 Background

Claire Westwood, having taught science for eight years on commencing the professional development programme, was the longest serving case study teacher. Since completing her teaching qualification, Claire had taught at one other school, before moving to St. Hilda's Church of England school. Claire was in-charge of Key Stage 4 (14-16 years) science and taught A-level chemistry[4] – the subject she read for her first degree. Claire's experience of teaching science outside was 'virtually none, it [was] limited to placing UV beads outside [a physics GCSE data analysis practical]' (Field-notes, Nov 2007). In contrast Claire referred to herself as an experienced CASE teacher having taught it continually throughout her career and having attended four Cognitive Acceleration (CA) conferences. Furthermore, St. Hilda's science department ran in-house CASE professional development – which she helped organise. Claire was knowledgeable about AfL and had completed a Master's module on Assessment.

[4] All the case study teachers teach 'science' across Key Stage 3 (11-14 years).

Claire's recruitment to the programme was the result of a long history with King's including the completion of a PGCE, studying for a Master's degree in Science Education (during the professional development programme), and mentoring King's PGCE students. Claire and I completed our teaching qualifications at King's in 2000-2001, and during my teaching career we had attended the same CASE professional development sessions. However, our professional relationship developed whilst working with pre-service teachers in my capacity as PGCE tutor.

St. Hilda's, where Claire taught the programme activities, was a Church of England girls' comprehensive school. In 2009 Ofsted graded the school as 'outstanding' and in the same year 91.5% of the Year 11 cohort achieved five GCSEs A*-C[5]. The school is centrally located in London on two sites; both sites have access to small-concreted grounds – one site has a small semi-mature garden (30m x 20m). Claire attended the programme with Charlie Pence – also a case study teacher – and they appeared to have established a very harmonious working relationship.

6.2.2 Beliefs

Claire believed that 'children mainly learn by constructing their own understanding based on their experiences and observations, and by discussing their ideas, and questioning [them]' (Professional information, July 2009). Her articulated belief concerning how children learn, substantiated by her dominant dialogic teaching approach, was aligned with a social constructivist position. Claire considered science as a means to make sense of the world; but reasoned that there were other methods through which this end could be achieved. She thought school science should prioritise the development of all students' scientific skills and their awareness of the applications of science and 'not just those who choose to pursue a career in science or engineering' (Professional information, July 2009). These beliefs were reflected in the learning objectives she presented to her students.

Whereas the beliefs reported above remained consistent over the duration of the programme, Claire's beliefs concerning teaching science outside changed. In Year 1 Claire believed learning outside enabled students to become more aware of their surroundings whilst restricted to biology related subjects:

[5] The percentage reported for all case study schools includes mathematics and English.

> Reflect on one idea that you have been struck by today. How can you implement this in your 'classroom'?
>
> Thinking about outdoors activities that aren't just biology based.
> (Session evaluation, Nov 2007)

At the end of Year 2 Claire reported many topics could be taught outside including concepts from chemistry and physics and that the outdoors were more conducive than the classroom for students' extended discussions. This she suggests was due to students being faced with real life examples inspiring discussion. Claire also noted that whilst offering challenge for the high attaining students, the outdoor context had engaged the low attaining students to learn science 'as they were free from the constraints (of the classroom)' (Interview, March 2009).

In Year 2 Claire acknowledged that essential to successful outdoor work was continually teaching students the skills of group work. Postulating that students, 'probably haven't been given that much responsibility before for extended periods of time [...]' whilst reflecting that,

> [...] one of the things we noticed last year (was) the focus went off the group work as we got onto the second or third lesson and not necessarily for the good as some of the groups got into bad habits. (Interview, March 2009)

Finally, towards the end of the programme, reflecting on the drawbacks of effective outdoor teaching, Claire considered a lot of time for planning was essential and that students were more inclined to become distracted. This final concern might be responsible for the restricted time given to students outside during a lesson, compared to that spent in the classroom and compared to other case study teachers such as Megan.

6.2.3 Teacher efficacy

Claire's teacher efficacy was judged as moderate-high in Year 1 increasing to high in Year 2. An example of her increased efficacy was evident in her mean rating in terms of her confidence to teach the activities as 6.5 in Year 1 increasing to 8 in Year 2. Using the RPTE analytical dimensions her teacher efficacy is discussed below.

6.2.3.1 Subject knowledge

Claire was consistent in trialling a range of programme activities across the spectrum of science subjects (see Table 6-1). Whole-class questioning inside, and small-group questioning outside was open-ended promoting challenge and it reflected Claire's confidence in her own subject knowledge. In spite of this, she believed that she lacked skills to teach outside compared to colleagues who were biology specialists:

> I am not a biologist, I've never been trained, if you like, in how to use an outdoor space, it's never been something that has been expected of me, to use an outdoor space.
> (Interview, May 2009)

By the end of Year 2 increased teacher efficacy can be detected when Claire trials the biology activity – Urban jungle – with a Year 10 GCSE class. She reflected that she felt able to teach the activity following a discussion with her (biology) colleague, Charlie, who had adapted and taught the lesson with his Year 10 class.

6.2.3.2 Flexibility and disposition

Claire had an enthusiastic disposition and a tremendous willingness to experiment with new ideas to develop her pedagogical practice. Towards the end of the programme she had trialled the majority of the activities, across multiple classes and on several occasions (see Table 6-1). In teaching the lessons she had maintained an explicit focus on the development of student skills, for example group work and later scientific observation. However, whereas Claire's classroom practice incorporated very proficient whole class open-ended questioning, this was not observed in her practice outside, nor was the use of *in situ* examples observed in her whole class teaching. Instead student learning outside occurred predominantly in small groups focusing on data collection. In Year 2 following logistical issues being identified as a hindrance to teaching outside, Claire organised for classes to take place in rooms with direct access to the outdoors. This might be considered an example of Claire's responsiveness to teaching challenges; but also might reflect her resistance – due perhaps to lowered teacher efficacy – to whole class teaching outside.

6.2.3.3 Teacher/student focus

Claire remained focused on her students' learning throughout the programme. She was supportive, personable and engaging and through dialogic teaching, encouraged the students to develop their own understanding. Although in Year 1 she encouraged students to take ownership of group work, it was during Year 2 that a sense of authenticity in the practice was observed. That is, although several strategies concerning group work were trialled in lessons, the explicit inclusion of time for group work reflection was only evident towards the end of the programme.

6.2.3.4 Behaviour management

Claire was observed to have good management skills. However, some reservation was detected in her belief in her ability to maintain order outside. Evident in the extract below, her concerns related to: students becoming distracted by external sources (such as wet grass, other classes) and the disruption her students might cause other (overlooking) classes.

> I: What are your reservations of using the outdoors?
>
> Claire: The grass is too wet to sit down on, although a couple of sixth formers were, they [the Year 9 students] wouldn't have sat down properly on the grass - they would have made a fuss. They could have sat down on the benches as they are a small group but I know 5 – 10 minutes before the end of the lesson the PE department would have trooped the whole of that group back across the playground so what you are doing gets completely disrupted though with netball hoops etc.
>
> Hmm… and again with this group [the Year 9 students] they are very difficult to get quiet and I am just aware of the lessons going on around that they can impact. Whereas other groups I may feel more confident doing it, and if it is dry enough to sit on the grass I'll feel more confident doing it, so that they are in a space, that people aren't going to troop through to and from PE lessons and on their way to lunch going down early, that sort of thing. So I am not against it *per se,* it is just taking all the other things into consideration.
> (Interview, March 2009)

6.2.4 Implementation of the programme

Claire successfully implemented the programme's pedagogical framework into her teaching practice. All the principles of the framework (and the overarching aim to teach science outside) were identified in practice, and noteworthy was the inclusion of scientific observation frequently omitted from other case study teachers' practice. The quality of Claire's practice improved: initially considered in Year 1 as 'successful' rising to 'very successful' in Year 2.

Claire had limited experience at the start of the programme of teaching outside, however by the end of the programme she had completed seven different activities and taught outside on at least 15 occasions (see Table 6-1). Whilst the programme offered activity ideas, her practice benefited from the strategies to organise students' learning outside. Overall, Claire considered the pedagogical framework a useful organisational tool for outdoor lessons. Persistent use reinforced the appropriate behaviours anticipated from students eventually enabling learning outside to become second nature:

> Claire: [...] Charlie and I found ourselves doing more outdoor lessons. So, today I had Year 9 outside this morning and they were videoing themselves on their mobile phones doing a presentation about global warming. But because it's the same group I've been doing the outside lessons with, when I said 'all right, we're going outside', they were like, 'ok, right, fine.' We'd reinforced the group work side of things with them four times previously. So, by the time it came to the lesson today, I didn't really need to do it. They got outside, they went to the same areas they'd worked in, knew exactly what they were doing. (Interview, June 2008)

Group work, as an aspect of the pedagogical framework, was explicitly seen within all Claire's observed lessons throughout the programme. It is a strategy which can be closely aligned with her beliefs about how children learn and an important 'pillar' of CASE theory of which she was highly knowledgeable. Furthermore, over the two years, I considered her group work pedagogy to improve. For example, during Year 2 Claire refined her practice by incorporating opportunities for student reflection on learning in a group. Presented originally during a professional development session during Year 1, Claire only realised the purpose of using group work when outside when she trialled the activities. The following extract illustrates how students were encouraged to take ownership and to work within groups. It also captures Claire's dialogic approach and use of open questioning, an aspect of the framework discussed below.

> Claire reminds the girls about when they last went outside. She asks them to consider the last time they went outside – what went well and why due to group work. Claire stresses that although last time was the first time they did group work outside they all do lots inside the classroom.
> Claire (C): Two minutes in your groups and thinking how can we make it really, really super today.
> [...]
> A PowerPoint slide displaying questions concerning group work is on the board.
> Claire asks girls to feedback their thoughts about group work - all students are attentive.
> C: What was the best thing that you did last week?
> She asks a particular group to feedback (named student).....
> Student 1: we all listened to each other.
> C: You all listened to each other. Who else thought that was an important thing to do?
> Hands go up.
> C: Does anyone else also think that they did something really, really well last week?
> Several students' respond. Claire echoes these responses back.
> C: What about things that we maybe need to improve on?
> Student 2: Being more enthusiastic
> Student 3: Being slower

C: What about your group? (Directed to a group that are yet to respond.)
Student 4: Working faster and being more together?
C: What do you mean by more together? How?
Student 4: Instead of like all doing stuff, same thing, someone could be the captain and give out the roles.
Claire asks if students could hear this, she asks two individuals by name. She then repeats, but asks student 4 if she had got her interpretation correct.
C: Who agrees that this is a good idea?
(Majority of hands go up)
C: So how can these things happen?
Student: All need to pitch in, and have different roles.
Claire states that girls need to consider how they might improve things today and gives them 5 more minutes to plan their group work.
(Observation, May 2009)

Claire understood the concept of cognitive conflict and was excited by the wealth of challenges the outdoors presents. Originally she found the openness of the activities a cause for concern, however on becoming more familiar with the activities, she felt more able to respond to 'new examples' offered by the students whilst maintaining the lesson's focus. Illustrated in the extract above, when appropriate, Claire was able to ask open and dialogic questions (for example – 'So how can these things happen?'). Only during Year 2 was Claire observed teaching scientific observation through the use of the outdoor activities. However, in Year 1, she explicitly acknowledged that by doing outdoor activities her students' observation skills were developed. That is, a product of working outside was that students were more able to 'give accurate descriptions of observations' and 'explain observations in terms of absorb/transmit *etc.*' (Session evaluation, February 2009).

6.2.5 Influential programme strategies

Claire attended five professional development sessions (being absent from session 4 only). Activities introduced through tutor simulated modelling – tutors acting as the teacher and teachers acting as the students – were noted as influential on practice. Claire reported that lessons introduced through this medium were the first to be trialled as they provided an insight into how students might react and offered exemplification of pedagogical practice. Initially, tutor-led simulated modelling concerning practical ideas was considered most useful for example, where to stand or how to distribute equipment. However, Claire gradually responded to strategies that were concerned with student skill development, for example, scientific observation. In additional to tutor modelling, activities were noted as more likely to be trialled if curriculum links were made explicit during the session. Finally, Claire noted that the variety of tutors involved in the programme sessions, as well as their specialist knowledge, enhanced her commitment.

Claire valued professional development when opportunities for reflection on practice were made available. Discussion with colleagues from her own school (Charlie) and different schools was felt to enable reflection – especially where experiences were shared over an extended duration. Her belief that co-reflection, facilitated through discussion, was vital for professional growth were articulated in Year 2:

> I think it [professional development programmes] gives you a chance to reflect on what you are doing anyway, because when you are talking about the ideas, quite often things are given a particular name, and it's not until you are talking about it that you go – oh actually I do something similar to that already. And so it's reflecting back on what's already going on in your practice, if you don't get a chance to talk about things and different ideas you don't really reflect back on what you are doing anyway. So having that chance to reflect on what's going on, and what's good about it, and what you want to change about it, and then thinking about how these new ideas, activities, tools, sort of help you improve on what you are doing, and improve the teaching and learning that's going on, by helping you sort of go through that cycle, that sort of constant cycle. (Interview, May 2009)

In school, the role of her colleague (Charlie) was seen as vital to Claire's continual commitment and subsequent development in her practice enabling her to: clarify professional development session messages; 'bounce ideas off' one another (Interview, March 2009); recall information; share lesson experiences; and, discuss lesson planning. Furthermore, although no formal presentation was given to colleagues more widely in the department, Claire involved departmental colleagues by making activities available on the shared computer portal and by organising for all Year 9 science teachers to teach a sequence of outdoor lessons following the end of the Key Stage 3 course during Year 2.

A further strategy Claire considered influential on her practice was tutor visits to school. The importance was two-fold. First, raising the status of the programme within the department and school and second offering an additional urgency to trial the activities. Finally, Claire was the only teacher participant accepting the offer to contribute to a conference; and did so on two occasions (CA conference March 2008; ASE South East conference June 2009).

6.2.6 Summary

Claire was committed to the programme from the outset but her enthusiasm grew over the two years leading to presentations at conferences. Claire was an experienced CASE teacher and her beliefs concerning teaching were aligned with those that underpinned the pedagogical framework. Rarely teaching outside before the programme, Claire's teacher efficacy increased as she frequently trialled a wide range of activities. Working with her colleague, Charlie, was beneficial in that they shared resources and reflected together on activities. Finally, group work could be identified as central to Claire's pedagogical practice – whilst in line with her beliefs concerning how children learn, it offered a tool to manage student learning outside.

6.3 Case: Michael Bison

6.3.1 Background

Michael Bison, an early career teacher, completed his pre-service training in 2006. His first degree was in physics. Other than science teacher and form tutor, Michael had no further responsibilities. Before commencing the professional development programme, Michael noted that his experience of teaching outside was limited to students measuring speed and using quadrats in the school grounds. Michael had limited knowledge of CASE theory – having received no formal professional development and was unaware of the meaning of the concept 'cognitive conflict' (Interview, July 2008). He explained that the department had the folder of CASE resources, which he occasionally tried if time was available at the end of a teaching sequence. As for AfL he acknowledged that he had received training, but perhaps with some scepticism considered a refresher useful:

> Lots of these things, most staff have already been over, it's not like… people have talked for many, many years, but as I've said before it's always good to renew these things in your mind, even if you do know them before. (Interview, July 2009)

Since completing his PGCE Michael had taught in Saviour's Girls' Catholic school – a Science and Mathematics Specialist School. Located in greater London, the school had a large area of outdoor space that includes: tennis courts; seated picnic benches; rose garden and two large ponds. Opposite the school lies a large public open space. In 2010, 82 per cent of the Year 11 cohort achieved five GCSEs A*-C and in the same year Ofsted graded the school as 'good'. In the report Ofsted (2010) commented that some lessons were less successful, such as in science and mathematics when teacher talk dominated students' involvement in their own learning. Ofsted also reported some inconsistency in the effectiveness of assessment procedures.

In Saviour's school, all members of science were expected to participate in professional development activities and a member of the science team was responsible for distribution of potential events/workshops/programmes. It was through this route Michael heard about the programme, recalling that 'teaching outside was something that I would be interested in doing, so I sort of enrolled on it then' (Interview, July 2009).

Michael and I had a satisfactory professional relationship over the two-year programme. That is, when prompted he returned emails and was interested in being involved in both the programme and the research. However, he did not always seem to be forthcoming in the research interviews; his responses felt more concerned with what he thought he should say, rather than his own opinion. This led him very occasionally in the interviews to become slightly defensive, and on several occasions his facial expression communicated a sense of exasperation towards the questions; however this was never verbally acknowledged.

6.3.2 Beliefs

Michael, responding to the question concerning how children learn wrote:

> Different children learn in different ways, some learn through doing practical activities others through study, others presenting ideas. I am sure there are many books that go into a lot of detail about this point. (Professional information, July 2009)

This pragmatic response was concerned with teaching methods rather than student cognition or social relationships; the latter part of the response might suggest an indifference to the question, or lack of knowledge. Michael consistently referred to teaching methods needing to offer variety, believing that if 'kids can be interested in it - a certain topic - then they may want to learn about it' (Interview, June 2008). However, the observed lessons, regardless of the teaching method used were consistently teacher-led and didactic. Or to use Scott and Mortimer's (2004) categorisation, Michael presented the learning from an authoritative, rather than dialogic, position.

Michael's epistemology of science was predominantly realist. That is, although there was evidence that theory was to be investigated, Michael never discussed the idea of rejecting hypotheses. Rather, existing theories were to be understood and then observed through investigation. Hence, to this end, Michael believed school science should prioritise the teaching of science theory:

> I: So outside you feel that your role really is managing? Where as inside your role is managing and….
>
> Michael: Well… it is learning outside as well, and that is the idea of going out - and trying to solidify some of the things that we did inside the classroom. So I wanted to have things inside the classroom first as I felt that gave them a bit of a basis for their understanding… outside. I mean we could have gone straight outside but I think that they would have been less directed and have had less understanding of why things are happening. And why things are happening as they were. (Interview, July 2008)

At the end of Year 2 Michael articulated the belief that learning science should involve the development of scientific skills, however his practice was observed to prioritise scientific knowledge. Finally, Michael believed that teaching outside offered variety and the opportunity to have fun for both him and his students, adding in Year 2, that it offered an opportunity for students to link classroom science to the outdoors. Michael believed that the main barrier to teaching outside was managing student behaviour.

6.3.3 Teacher efficacy

Michael's teacher efficacy remained consistently high over the two years. For example, his average (mode) confidence score was 9 to teach the activities (see Appendix 16). Conversely the RPTE analysis suggested a moderate to low rating. Using the RPTE analytical dimensions his teacher efficacy is discussed below.

6.3.3.1 Subject knowledge

In total, Michael trialled four programme activities from a range of science topics. However, the activities repeated most often were physics related – for example, Rose-tinted glasses. Michael's physics knowledge when observed was more in-depth than his biology knowledge; potentially explaining his preference for physics related activities. Michael did create a PowerPoint resource – however the majority of slides were concerned with imparting science theory.

6.3.3.2 Flexibility and disposition

Michael's disposition was considered apathetic – there was a sense of getting through activities and the programme sessions rather than engaging with them. His interviews portrayed an understanding of pedagogy – such as AfL – that was not always evident in practice. That said, Michael's attendance at five of the sessions and an attempt to trial some activities outside, suggested a willingness to experiment (see Table 6-1). However pedagogical risk-taking was restrained with limited change in pedagogical practice observed and in Year 2 only two activities were trialled.

Although no science colleague accompanied Michael on the programme during Year 1, in Year 2 a maths colleague from Saviour's, who was an ex-student at King's, joined the programme to develop outdoor maths-related activities. Michael, however, made no attempt to work with the teacher, and whilst acknowledging the usefulness of physics and maths teachers cooperating, considered cross-department links the responsibility of the head of department.

6.3.3.3 Teacher/student focus

Michael's focus was on his teaching rather than the students' learning. That is, during interviews he neglected to comment in any depth as to what particular groups/individual students might gain from different teaching methods – other than that they would have fun. In Year 2 he describes his role outside as a guide – which was observed as him leading the students outside as a whole class and pointing out observations to be made. 'The examination' has an overt presence – in interviews and during teaching – which seemed to steer pedagogical decisions. This factor, combined with Michael's focus on being a guide, resulted in students being told what they needed to know, with what seemed little regard for particular learners' needs. When observed in Year 2, he used few student names, seemed quite aloof and was at times critical of students' efforts.

6.3.3.4 Behaviour management

Michael explicitly highlighted that he was 'not the master of behaviour management' (Interview, July 2009). Furthermore, evident in the extract below was a resignation that students would always present challenging behaviour:

> Well obviously just taking them out just has it's own challenges, different people wandering off.
> […]
>
> 'My role outdoors? ... [...] certainly managerial trying to keep them all, I mean that is like inevitable whenever you are teaching there seems like there is quite a large level of management involved.
> (Interview, May 2008)

6.3.4 Implementation of the programme

Described below are the aspects of the programme's pedagogical framework identified in Michael's practice. Overall Michael's implementation of the programme's framework was considered 'moderately successful – unsuccessful' in Year 1, and 'unsuccessful' in Year 2, when compared to the other case study teachers. That is, although Michael did teach outside his implementation of the pedagogical principles was weak.

Taking each pedagogical principle of the framework in turn, the inclusion of group work was observed superficially. For example, during Year 1 Michael encouraged students to set their own rules. However, rather than student groups compiling the lists, they were asked to think about them individually, reciting them to the class:

> Michael: 'We are going to go outside and find objects that are different colours.'
> Michael explains how the table should be completed that he has given to each group. He then goes through the rules by asking: 'who can think of some basic rules for working outside'. The girls give him answers. They shout them out. One student comments 'we've done this before'.
> Michael repeats the rules to the class. The rules include:
> Don't sing/shout
> Be quiet
> Stay close to sir
> Don't drown in the pond
>
> Girls' then are told to meet downstairs.
> (Observation, July 2008)

A further example of the group work principle was evident in Year 2 when students were asked to take on roles in groups, such as, scribe and equipment holder. However whereas reflection time on the use of student roles had been discussed during the programme session as worthwhile this was not a feature observed in Michael's lessons.

The second principle was cognitive challenge. Michael initially misunderstood the concept, and therefore it was not implemented during Year 1. In Year 2, Michael articulated the concept as a 'hook' to evoke student interest. However in the observed lessons the 'hook' or challenge was lost, possibly due to Michael's science epistemology, which results in scientific theory being presented at the start, decreasing the opportunity for 'surprise'.

Michael's questioning, during Year 1 was predominantly closed and of the form Initiate-Response-Evaluate (I-R-E) form. When he did ask more open-ended questions he was often observed to answer the questions himself:

> Michael: What is a habitat?
> Student 1: Place where animals live
> S2: Where you get food – in snow
> S3: …Rainforests?
> S4: Birds nest…
> Michael: Okay fine, it's the environment where any living thing lives.
> (Observation, July 2008)

However, in Year 2, open questions were used directly from the activity sheet and students were given time to discuss their answers. Regarding the final principle, scientific observation, no explicit teaching to develop students' skills was observed.

6.3.5 Influential programme strategies

Michael attended the majority of the programme sessions (missing only session 6). He valued the new ideas offered by the activities, especially when they were presented through a tutor-led simulated modelling approach – teachers as students and tutors as teachers. He particularly valued it when activities had a novel resource attached, such as the coloured filter glasses or the egg-boxes. When activities were only read-through, where no physical item was central to the teaching or where the objective of the activity was a little ambiguous, Michael was less likely to trial them. Discussions concerning pedagogical ideas, such as group work and scientific observation, which were separate from an explicit activity, seemed to have little influence upon his teaching practice. However teacher discussions, generated by a structured period of reflection on individual activities, were influential on Michael's practice. These aspects of the discussions that bore an influence on Michael's practice were mostly concerned with easily transferable practical teaching tips such as: setting invisible boundaries and the use of coloured markers on the board whilst wearing filtered glasses.

Michael in school did trial several of the activities – however the number was greatly reduced in Year 2 (see Appendix 21). In school he worked on the programme alone, commenting that other staff were too busy to be involved. He informally shared one of the activities – Rose-tinted glasses. That is, colleagues seeing students outside wearing the filter glasses questioned Michael about the activity, leading to several teachers borrowing the equipment and trialling the lesson. However Michael did not share the lesson activity sheet with colleagues or discuss the underlying pedagogical framework. Similarly, as previously mentioned above, in Year 2 a maths colleague joined the programme but they did not work together in school.

Further aspects of the professional development which were considered to have influenced Michael were the tutor visits. The frequent prompts (via email) encouraged him to trial the activities. Although an aspect of the research, rather than the programme, the research interviews occasionally acted as a source of professional development. For example in Year 1 when following a question regarding cognitive challenge Michael asked for the term to be explained and for exemplification.

6.3.6 Summary

Michael's commitment to the programme was questionable – although attending the majority of sessions, he trialled few activities during Year 2. His teaching approach was authoritative and didactic – behaviours associated with traditional beliefs about teaching – inconsonant with the social constructivist approaches promoted by the programme. Michael's teacher efficacy was judged as moderate-low: evidence of this rating was observed across all RPTE dimensions, being particularly visible in his lack of flexibility to adjust practice dominated by a teacher-centric approach. Overall, the programme had limited influence on Michael's teaching practice.

6.4 Case: Charlie Pence

6.4.1 Background

Charlie Pence, an early career teacher, completed his pre-service training in 2006 at King's. His first degree was in biological sciences. He had taught at one institution – St. Hilda's Church of England Girls' school. Part way through the programme (September 2008), Charlie become responsible for the STEM after-school club, previously having no additional responsibility beyond subject teacher and form tutor. Charlie's experience of outdoor teaching included organising an A-level biology day visit taught by the Field Studies Council and annually teaching Year 8 sampling skills in the school grounds (Field-notes, Nov 2007). Charlie took part in the programme with a more experienced colleague: Claire Westwood (see Section 6.2 for Claire's case study). Charlie and Claire had a very harmonious working relationship. Claire's case study describes the context of St. Hilda's school (Section 6.2.1).

During the first year of the study Charlie attended St. Hilda's in-house CASE training and taught numerous CASE lessons. These experiences benefitted the programme, enabling a deeper understanding of the concepts, such as cognitive challenge. However, by completing the programme simultaneously, several drawbacks were identified. For example, Charlie's expectation, arising from the CASE training, was that cognitive challenge would be made explicit within the activities. Where this was not the case for the outdoor activities, he initially found it difficult to include in his teaching. Furthermore, CASE emphasises that time generating data should be reduced so that more time is spent thinking about the challenge. Hence, due to his conceptualisation of the outdoors as a context for data collection only, he spent limited time outside (approximately 5 minutes) attempting to reduce students' data generation time.

St. Hilda's was a partnership school with King's PGCE programme. Charlie heard about the programme when he was involved in PGCE candidate selection, and it was through this process that we initially became acquainted. Over the two-year programme a very positive and open professional relationship developed between Charlie and myself. I considered Charlie to be committed to the programme, not only in trialling many lessons (see Table 6-1), but also by finding solutions to barriers for example, reorganising teaching locations to access better quality outdoor teaching space.

6.4.2 Beliefs

Charlie considered learning to be socially constructed. This notion, that students have to construct their own understanding, was to an extent reflected in his response to the question how do children learn, 'Through experience, problem solving, discussion and explaining thinking' (Professional information, May 2008). However, Charlie's social constructivist beliefs were further revealed in his teaching practice. For example, he encouraged students to listen and reflect on responses they heard (and not just the teacher's):

> Charlie gives students two minutes in groups to talk about how the Sun is causing these things [(for example fading, growth, evaporation)] to happen.
>
> Two girls sitting near me weren't sure how the Sun makes things fade, but talked about it heating up cars (rays, hot metal, molecules move)
> -- they were definitely cognitively engaged, challenged.
>
> A whole class discussion commenced about evidence of the Sun.
>
> [...]

Girls tended to begin with fairly straightforward description, and then Charlie pushed them
For example,
Student 1 (S): Leaves drying out
Charlie (C): but *how* does that happen?
S1: Heat from the Sun was cooking it.
C: Do we agree?
S2: No, it's evaporating

[...]

C: What do you think about that, Helen?

Charlie gave them a few examples of things to think about.
C: How can there be different kinds of signs, if this is all to do with the Sun?
Had students discuss for one minute.
Girl near me said something about converting energy, different kinds of energy.
(Observation, July 2008)

As is clear from the extract above, Charlie's teaching approach was predominantly dialogic. Charlie's science epistemology was 'interpretist'; that is, he considered there to be more than one way to understand the world. Charlie believed the priority for school science was for students to understand the nature of science followed by scientific knowledge. However, this belief was not observed in practice until Year 2 – scientific knowledge dominating learning objectives during Year 1 observations.

Finally Charlie's beliefs concerning the benefits of learning outside changed. In Year 1 he considered the outdoors offered opportunities for data collection, pedagogical variety, and novelty and excitement. Whereas, in Year 2, he emphasised the multiple benefits offered to students' learning including: memorable, unique and challenging contexts to apply science understanding; opportunities to 'observe' science in the 'familiar' making it less abstract; and, opening students up to understanding more of their natural world. Beliefs concerning barriers to teaching outside remained constant – that is students were considered more likely to misbehave or become off-task when outside.

6.4.3 Teacher efficacy

Charlie's teacher efficacy was judged as moderate in both Year 1 and Year 2: this consistency was reflected in his confidence scores to teach the activities ('7') and in comments such as '[Inside] I feel more comfortable than outside' (Interview, June 2009). Generally the RPTE reflected the teacher efficacy, however, in Year 2, the RPTE was considered slightly higher at moderate-high. Using the RPTE analytical dimensions Charlie's teacher efficacy is discussed below.

6.4.3.1 Subject knowledge

Charlie was observed to have good subject knowledge enabling him to trial activities from across the sciences. His teacher efficacy was considered to increase as his subject knowledge (and pedagogical practice) developed following the initial year. Increased teacher efficacy was evident in: an increased use of examples from outside whilst teaching (especially in teaching physics related activities); an increased ability to pose challenges pitched at the appropriate level; his development and use of effective open questions; and his re-trialling of activities initially rejected in Year 1 – yielding positive outcomes.

6.4.3.2 Flexibility and disposition

Charlie was enthusiastic and open to ideas. On commencing the programme Charlie was considered to be quite flexible and open to change, trialling new aspects of pedagogy such as group work. However his flexibility increased greatly during Year 2, for example he was observed adapting and developing activities from the original plans for his specific context depending on the ability of his classes. In addition, compared to Year 1, extended periods were spent outside, with less time exclusively used for student data collection, and more used for group and whole-class teaching.

6.4.3.3 Teacher/student focus

The teaching context influenced Charlie's teaching approach. That is, inside the classroom Charlie's approach was predominantly student-led compared to outside, where it was observed as teacher-led. As noted above, there was some evidence of a change during Year 2 whereby Charlie's practice outside became more student-led.

6.4.3.4 Behaviour management

Charlie was observed to have very good student management skills. However, similar to the former dimension, Charlie's approach to behaviour management was influenced by the context. Inside the classroom, pedagogical choice dictated student behaviour, whereby use of explicit behaviour management strategies was rarely observed. Conversely, outside, the management of students often dictated the teaching approach chosen. This practice seemed related to a 'fear' that students would misbehave:

> I'm more comfortable inside but it would help if we did do it outside I think as the examples are around us easily and we can look at them again *etc*. I use the board a lot to focus their ideas, and that isn't there. I think it is more me, and trusting them. Trying to gather their ideas might be difficult, they might be difficult; there might be too many distractions. But saying that they might get over this with practice. […]
> (Interview, May 2008)

Related to this 'fear' was a concern that colleagues might observe his students behaving poorly. Charlie reported only positive behaviour of students whilst outside, and although some change was noted in Charlie's teaching approach, he continued to articulate the fear of potential student misbehaviour when outside.

6.4.4 Implementation of the programme

The programme's pedagogical framework was successfully incorporated into Charlie's teaching practice (considered 'very successful' in Year 2). Charlie taught for longer periods outside, and except for scientific observation, all the pedagogical principles were identified in his practice. The pedagogical principles are considered below.

Prior to the programme, the majority of lessons Charlie taught outside were ecology related. Hence being involved in the programme stimulated Charlie to extend his teaching repertoire and acquire new outdoor activities he had not previously associated with science. However, in Year 1, the outside remained a site for data collection with the 'proper' teaching being restricted to the classroom. In Year 2, more of Charlie's teaching occurred outside involving whole class and group discussions. Charlie began to consider how to organise outdoor teaching, including where to gather students together and good outdoor examples to stimulate discussion. Group work, an aspect of the programme pedagogical framework, was relatively easily drawn into Charlie's teaching repertoire. His students were familiar with working in groups in his lessons and in Year 1 he encouraged students to set their rules. However, it was not until Year 2 that he ensured time was available for students to reflect on rules and he was able to acknowledge the importance of group work.

Due to his experience of CASE, Charlie has a good understanding of cognitive challenge from the outset. However, due to the openness of the activities, multiple cognitive challenges were simultaneously introduced to students during Year 1 with no particular focused challenge. During Year 2, Charlie became more able to focus students on specific challenges. It might even be said that he started to relish 'real' challenges as he commented that he had started to introduce them more widely across other lessons.

During an observation the following questions were listed, illustrating the quality of Charlie's questioning:

> What could you go back and collect to be able to make an even better judgement?
> How else might you sample the water?
> Would it be the same if we returned to the habitat next week, in a month?
> How else could you study the habitat?
> Charlie does not give any answers, he echoes back and asks other pupils what they think of others' responses
> (Observation, February 2009)

Charlie made good use of open questions and was able to engage students in extended dialogue, whilst encouraging other students to listen and respond. The open questions mainly came from the programme's activity sheet during Year 1; however this practice became less apparent in Year 2 when he developed his own 'more off-the-cuff' questions. What's more in Year 2 as Charlie taught outside more frequently, his open questions were less general and more specific involving 'real life'/*in situ* examples.

6.4.5 Influential programme strategies

Charlie attended five programme sessions – being absent from session 4 (as was his colleague Claire). In Year 1 he stated that an influential strategy was receiving new lesson activities which were easily transferable into school, with clear learning objectives (in either paper or electronic form). Returning to school, the activities that had been modelled during the sessions were initially trialled. Charlie appreciated the opportunity to take the role of the student 'seeing the activity through their eyes' (Interview, March 2009). Pedagogical ideas, such as group work, were only observed in practice when practical strategies had been discussed in the sessions.

During Year 1, Charlie trialled a range of activities with different classes (see Table 6-1). These activities were completed in an *ad hoc* manner and were not fitted into a related lesson sequence. Lesson choice was usually the result of a discussion with his colleague (Claire Westwood). He involved the student teachers by encouraging them to trial the activities, which he then observed. Charlie reported that school visits from the programme tutors and the evaluator added an extra stimulus to trial activities. However, the observation notes sent following the visit stimulated little response or reaction.

Charlie's engagement with the programme increased. One of the objectives of the programme was to produce activities grounded in trialled pedagogy. For Charlie, this outcome became increasingly important to his continued engagement with the programme. That is, that the programme was 'authentic' and organic – seen as 'bottom-up' rather than 'top-down':

> (The professional development is) very discursive and the session that you run are open-ended and teachers share ideas and share good practice.
> […]
> I enjoy the sessions we've had […], the opportunity to be involved in the development of something, and it does feel like we are involved in the development of it, that our ideas are useful to construct a programme.
> (Interview, March 2009)

Although receiving new activities was consistently acknowledged as being required for effective professional development, compared to the first year, its significance decreased. A practical example of this change was observed during session 6 when an old activity (Materials) that the majority of teachers had either not taught or struggled to teach was discussed and issues were raised with potential solutions given. At the end of this session Charlie, unprompted, offered to re-trial the activity, to implement the changes discussed, inviting a tutor to observe. Furthermore, during Year 2 Charlie was observed implementing practices into his teaching that had directly arisen from two Year 1 sessions; that is, a teacher-led presentation (on student management) and tutor-led whole group discussion (on group work). These strategies, which were not observed in Year 1, had been returned to in a discussion during session 5, and it is inferred that this revisiting of ideas stimulated Charlie to trial the previously introduced techniques. This inference is also linked to Charlie's comment that he greatly appreciated the discursive nature of the sessions (see extract above).

Charlie valued professional development when colleagues worked together – from the same department and from different schools. He noted that working with his colleague – Claire Westwood – greatly influenced his engagement. He highlighted that this was due to her enthusiasm and also her position as head of Key Stage 4 science, which he felt helped raise the status of the programme with colleagues in the department.

6.4.6 Summary

Broadly speaking, throughout the study, Charlie's beliefs were congruent with the theoretical framework underpinning the programme. His teacher efficacy remained moderate over the programme duration, however, my perception was that it changed from moderate to moderate-high. This increase in teacher efficacy largely rests on the domain 'flexibility' where he was observed to become increasingly able to adapt his practice to the outdoors. However, the belief that students would misbehave outside, more than inside, and his unsubstantiated belief that he would not be able to manage such disruption suppressed his teacher efficacy.

6.5 Case: Megan Thomas

6.5.1 Background

Megan completed her pre-service training in 2004 at King's. She had taught at one school – St. Patricia's – since her graduation and in 2007 became responsible for Key Stage 3 science and 'Student Leadership'. Her first degree was in pathology and microbiology. In 2008, whilst involved in the programme, Megan completed a Master's in Science Education at King's. As a direct result of being involved in the programme, Megan focused her MA dissertation on students' attitudes towards the outdoors. Prior to the programme, Megan organised an annual residential A-level biology field course run by the Field Studies Council. Over the years she had included the use of the outdoors into her lessons in variety of ways including organising a project to breed and release trout into a local river and designing a digestive system with a 'wet route' (outside) and 'dry route' (inside). Megan encouraged a biology colleague whom she felt lacked confidence to use the outdoors to participate in the professional development programme. The colleague, however, left the school during the first year of the programme.

Megan had taught CASE lessons from the start of her teaching career and commented that the openness of the outdoor activities captured the spirit of the CASE programme in that students were given the opportunity to develop their understanding without feeling restricted to find the right answer. In an unofficial capacity, Megan was responsible for organising the department's CASE programme, requiring her to ensure that all Key Stage 3 classes were taught CASE activities. To support teachers, Megan had organised CASE department training – inviting a CASE 'expert' to lead the session. Furthermore, colleagues frequently observed her teaching CASE lessons. As to AfL, Megan felt that effective teaching required the inclusion of formative assessment strategies. As Key Stage 3 science coordinator, Megan ensured that AfL strategies were explicit throughout the schemes of work.

St. Patricia's Girls' School was a large comprehensive faith school situated in Greater London. In 2008, Ofsted graded the school as 'outstanding'. In 2009, 84% of the Year 11 cohort achieved five GCSEs A*- C. The school is set in over 25 acres of ground with a variety of habitats, including woodlands and ponds.

Megan had been invited to be involved in the programme due to her past interest in teaching outside. I originally met Megan during her pre-service training when I was her school-based mentor. Megan was also a mentor for King's PGCE science students. Over the two-year programme, Megan and I had a very good professional relationship.

6.5.2 Beliefs

Megan believed that children learned,

> By experiencing many varieties of activities that are challenging and engaging thus enabling them to find out information for themselves. (Professional information, February 2009)

Whilst her response, like Michael's, focuses on the role of teaching strategies, her emphasis on students being able 'to find out the information for themselves' might suggest a constructivist belief concerning learning, whilst her teaching approaches reflected a social constructivist position. For example, she encouraged group work and consistently adopted the role of promoter and encourager during questioning rather than telling students the answer.

Megan believed that school science served two roles:

> To provide pupils with essential skills needed throughout life for example, analytical, evaluative, investigative. To give them an understanding of the way they and the things around them function and interact. (Professional information, February 2009)

The response exposes Megan's belief that science is more than an accumulation of subject knowledge, and that understanding the nature and processes of science were essential life skills. Related to this position, her reasons to teach outside were initially articulated as offering opportunities for student skill development and subject interconnectivity. However, in Year 2, her beliefs were observed to be more holistic; that is learning outside afforded students an opportunity to understand their environment both locally and further afield, in and out of the context of science. During Year 2, Megan noted that students needed to become confident in working outside prior to learning taking place. For this to happen, she explained, teachers need to develop the necessary skills, such as group work and observation whilst spending time within the context so that familiarity with the skills and the context could occur.

6.5.3 Teacher efficacy

Megan's teacher efficacy and RPTE were considered high for the programme's duration. She was enthusiastic, realistic and willing. She trialled all the activities, on numerous occasions, across multiple classes – including A-level biology - adapting the activities in line with students' abilities. She taught for extended periods outside (for example, 40 minutes of a 90 minute lesson), was observed including both whole class and small groups in her teaching repertoire, and encouraged students to refer to examples *in-situ* during their explanations. She noted that she had developed several new management strategies which were different from those she used inside (such as using timers for group work) and that she felt they enabled her to be a more effective teacher. That said, Megan's teacher efficacy was not rated as very high due, for example, to Megan's reticence towards being considered an expert in CASE. Furthermore she was able to identify aspects of her teaching that needed development:

> I: What have you developed during the programme?
>
> Megan: Hmm… improving my questioning skills which I think are quite important. It is one of the areas that I have always worked on […] … I also think it has improved it, as you are never perfect. That has been quite handy. And also from the point of view of almost a confidence of letting the kids go with it. Do you know what I mean? It is almost [that it gave] you a bit more, just let them go and see what happens, as quite often you tend to, as teachers, rein in a bit and think, I've given them a bit of lea-way so now pull them back in, instead the idea [from the programme] is very much let's just see what happens […]. (Interview, April 2009)

The final point in the extract above highlights Megan's initial hesitance to hand over control to the students and her subsequent empowerment to do so due to her involvement in the programme. Megan suggests two further reasons for feeling able to take pedagogical risks as: good student behaviour and the quality of the school grounds:

> […] behaviour is less of an issue with the girls, and therefore we are fairly comfortable with taking them outside, because they are good. And they are easy to take because it is in a contained area. It's a very different situation if you haven't got this sort of area, I imagine, and the calibre of kid. They are super. (Interview, June 2009)

Hence, if students had been more likely to misbehave she possibly would have been more hesitant to teach outside.

6.5.4 Implementation of the programme

Megan's practice embodied the desired outcomes of the programme's pedagogical framework. Viewed as 'very successful' implementation, Megan's increased focus during Year 2 on group work and scientific observation skills were in direct response to her identification of the essentiality of these aspects whilst outside. For example, although students worked in groups during Year 1, no explicit guidance was offered to them on how to develop their group skills. In Year 2, however, in spending time engaging students in the importance of group work rules – including the process of reviewing rules – she begins to see it as a necessity if students are to manage their own behaviour, and therefore learn, whilst outside.

Unlike the majority of case study teachers, Megan was keen to encourage students in the development of scientific observation. Due to her biology training she initially included the use of identification keys in her lessons. In later lessons she used the observation activities – adapting and extending them where required.

6.5.5 Influential programme strategies

Megan attended five programme sessions (being absent from session 6). During the sessions she valued trialling the activity to observe how it might be successfully taught. She considered it useful that that activities were 'quite self explanatory' – and that lessons were related to the National Curriculum, ready to trial and all the resources were available to take away:

> I think it has got to be something that you can actually take back into the classroom, as when you go back, there is not a lot of 'doing something' so that when you go back you've not got to spend weeks planning and prepping to put together, as with the best will in the world you just do not have time. You'd like to, it would be great, but you have one day at the place [the professional development session], and then when? You just don't have the time to do it… So the nice thing with these ones is that you did have something that you could

> literally come straight back in and use. And yes you may have had to tweak the odd little bit here and there as it didn't necessary suit your particular class or didn't like a particular activity within it, but as a principle because you were given an electronic copy that was easy. So you didn't have to cut and paste or stick stuff together. And also it was, the general frame was there so it was quite easy to pick it back up again. (Interview, April 2009)

Megan highly valued conversations with colleagues from other schools. During a programme session in Year 1 she gave a short presentation of strategies she had found useful whilst teaching outside. Many of the strategies were later observed in other case study teachers' practice (for example, use of timers and setting imaginary boundaries).

By the end of the programme Megan had trialled all the activities across a range of classes. She encouraged her student teacher and colleagues to trial the activities through a short presentation to the department (during Year 1), followed by an extended session during Year 2, highlighting the importance of group work to colleagues

> So I went through how I'd set up a group, and all the different options, and setting the rules, and I stressed the fact that some of the most important bits that I found, in particular from the Egg Box, was actually going through the evaluation of what worked and what didn't, so they know that when they do then get on to the main ones they know the rules, *etc*., of the groups. (Interview, June 2009)

In addition, at the end of Year 1, she gave a whole-school presentation about the programme and her MA dissertation findings.

Megan valued tutor visits, feeling that they motivated her to reflect in more depth on her teaching. She did not use the reflective journal – saying that she had not had the time. Finally, Megan commented that the funds offered by the programme to cover supply teaching and travel costs were crucial to her school allowing her to attend the programme sessions.

6.5.6 Summary

Megan was experienced in teaching biology outside and was knowledgeable about CASE and AfL. Her teaching reflected a social constructivist approach and she had a holistic view of teaching outside. Megan had high teacher efficacy and was fully committed to the professional development programme.

6.6 Case: Cara Brown

6.6.1 Background

Since completing her pre-service training in 2002, Cara had taught in two schools, spending three years at her first appointment before joining Nearside College in 2005 as head of Key Stage 3 science. She had a BSc in human biology and a science PGCE. Prior to the programme, Nearside College had been involved in the London Outdoor Science project and although Cara was a biologist the project had led to her first experience of teaching science to Key Stage 3 students outside. Cara had escorted A-level biology students on a residential field course – an experience organised by her head of department.

Cara had no previous experience of CASE and initially was unaware of concepts such as cognitive challenge and metacognition. Cara was, however, very familiar with AfL and the inherent practice to which it was bound. Commenting that she 'loves AfL', Cara believed that by asking open-questions she was able to gain 'a clearer sense of what [the students] know and understand' (Interview, July 2008), whilst acknowledging it as a tool for students to guide their learning.

Nearside College is a large mixed inner London comprehensive for students aged between 11-19 years. In 2009, 57% of the Year 11 cohort achieved five GCSEs A*-C – a 10% increase since 2007. In 2008, Ofsted graded the school as 'satisfactory'. The report commented that,

> Behaviour is good and a tribute to both the students and to the hard work undertaken by the staff to implement the school's behaviour policy consistently. (Ofsted, 2008: 4).

This point has particular relevance as student behaviour consistently concerned Cara during the programme. Nearside College had limited school grounds – concrete dominated the landscape whilst two small Astro Turfed football pitches were at the rear of the building. Several well-established trees and large concrete planters provided decorative planting.

Following the department's involvement in London Outdoor Science (in 2005-6), Cara's head of department encouraged her to be involved in the 'Thinking Beyond the Classroom'. The head of department, who was also a member of the senior staff, left the school during the first year of the programme. Cara and I had a good professional relationship, however it did not develop due to her frequent absence from the programme during Year 2.

6.6.2 Beliefs

Cara believed children learnt though 'engagement in their work, ownership of task and enthusiastic teachers' (Professional information, June 2008). These beliefs were substantiated in an observation; Cara encouraged students to work together – independently of her. Her pedagogical practice inside, described as dialogic and interactive, can be aligned with a social constructivist position. Noteworthy was the absence of this practice outside – a point returned to below.

Cara believed that teaching school science was important 'as it explains so much of what is happening around [the students]' (Professional information, June 2008). She also thought it was important that students were able to apply their science knowledge. Furthermore, Cara considered school science to have an important role in developing students' social skills – beliefs reflected in Cara's lesson objectives.

Cara's beliefs concerning teaching outdoors were consistent over the programme and wide-ranging. That is, Cara believed that teaching outside enhanced her practice making it 'interesting and exciting', enabling the students to 'interact with their environment' whilst 'making it a bit more relevant to them' (Interview, June 2009). Although only observed as a place for data collection, Cara expressed a belief that the outdoors could offer students the opportunity to understand challenging science topics:

> I did the Egg Box last year and again this year, because I think it's a nice way of consolidating a little bit of understanding, bits and pieces for end of year exams and things. [...] Forces All Around Us, because forces is so abstract it was really helpful for getting them out and experiencing it. (Interview, June 2009).

However, although Cara articulated the beliefs above, she taught few activities outside during Year 2, stating that it was due to a lack of time. However Cara's belief that students would behave poorly when outside, compared to in the classroom, remained consistent over the two years (discussed further below). Furthermore other challenges to teaching outside that she identified included: the requirement for additional support staff; increased planning workload; poor weather; and, locating good examples within the school grounds.

6.6.3 Teacher efficacy

In Year 1, Cara's teacher efficacy and RPTE were moderate-low. Her mean confidence rating was 6.8, and her STEBI score, although high, was joint lowest compared to the other case study teachers (see Appendix 17). However, where her teacher efficacy was considered as moderate during Year 2, the RPTE remained unchanged. This difference is explained below.

Cara's moderate-low teacher efficacy related to her belief that students would behave inappropriately outside. Although observed to manage students extremely well both in and outside the classroom, Cara seemed continually surprised that this was the case. For example, in Year 1 she said, 'I was initially a bit worried about the behaviour but they seemed to enjoy it and got very excited' (Interview, June 2008), and 'I felt very wary about going from inside to outside but I think it went well' (*ibid.)*. When outside, Cara was observed in the role of facilitator, meaning that she managed groups, ensuring they were on-task. Cara notes her role outside was, 'Keeping them concentrating, keeping them on task… like a policewoman' (*ibid.*).

In Year 2 Cara reported feeling less anxious about teaching outside (hence the increased teacher efficacy rating):

> I'm somebody who probably shied away quite a bit from taking kids outside because I'd be worried about disrupting other people's lessons and just the management of it all. It's given me confidence to do that now. (Interview, June 2009)

The increased teacher efficacy might have been due to her increased exposure to teaching outdoors (during Year 1) and her identification of group work as an essential ingredient for successful outdoor teaching (discussed in Section 6.6.4).

However, other than Cara's inclusion of two activities into the Key Stage 3 scheme of work, a limited attempt to trial activities during Year 2 was made. Hence although she reported feeling more confident, in the same interview responding to questions of why she might not complete activities outside she said,

> […] because you have very difficult behaviour groups to deal with, and sometimes it might not seem like it's worth the effort, unfortunately. […] I think that it's just,

> you have to plan more to do something like that outside, and I think time restrictions.
> […]
> I think it's the fact that you worry that they won't recognise that outside, [or it will not] be what you want it to be. […] just a bit unsure of what they are going to find.
> (Interview, June 2009)

This response, concerning her students' unpredictable behaviour, the uncertainty of what might be found outside and her lack of practice, might call into question her articulated increase in teacher efficacy.

6.6.4 Implementation of the programme

Cara's implementation of the programme was judged as 'moderately successful' in Year 1, and although unlikely to change due to her lack of practice outside during Year 2, no judgement was made due to the lack of observed lessons. Taking each principle of the pedagogical framework in turn, Cara was observed implementing some group work strategies into her practice. For example:

> Cara states that part of the challenge today is being able to work in groups, going on to comment that they are not used to working in groups.
> 'You'll all have specific roles, so in your groups I want you to give yourself a letter – A, B, C – with group's of four having two B's'.
> (Observation, June 2008)

However, this attempt at group work was considered rather superficial as students were not asked to consider what their role might necessitate neither were students invited to reflect on their group learning. However when asked about how she felt the implementation of group work had gone, she emphasised that it was important as a method to manage student learning:

> It worked well once I'd really drummed it into them how I expected them to work and what roles they had in their groups and everything. I think that's the key – giving them all something to do because they're quite happy to let one person lead, and just mill about doing nothing. So, having roles and talking about ground rules beforehand really makes a difference. (Interview, July 2008)

Although the term cognitive challenge was new to her, the concept was present in Cara's practice. Cara described it as something the students needed to work out, not to be given away by the teacher. For example, in an observation (June 2008) the 'challenge' for the students in the first instance was to determine what was meant by a habitat and then to consider what data was required to be collected outside to support their claims.

Cara's questioning was generally open and included students from across the class. For example:

> Following on from the photos, Cara asks students, "how did you decide if somewhere was a habitat? Were there any that you weren't sure about? Did you have any disagreements?'
> These questions were also displayed on the IWB. (Observation, June 2008)

Questions, such as those above were frequently drawn from the activity sheets. She valued the question stem tool, and although introduced during a programme session as a method for developing teacher questioning, Cara gave it to students for them to design effective questions.

Cara was not observed attempting to develop scientific observation skills with her students outside. Activities were limited to data-collection, with students spending a maximum of 8 minutes, of a 60-minute lesson, outside.

6.6.5 Influential programme strategies

Cara attended all of the programme sessions in Year 1, but was unable to attend any sessions in Year 2. Cara trialled four of the ten activities on eight occasions with two Key Stage 3 classes (see Table 6-1). Cara valued many aspects of the sessions including working with colleagues, sharing ideas and trialling activities:

> I think it's working with the same people as well, and sharing practice, which quite often at INSETs it's people talking at you, and not necessarily sharing your ideas and your thoughts about things [...] (Interview, June 2009).

> Getting the chance to try some of the activities before you then try them with your kids, so that you can kind of see from the perspective of the student [...] (Interview, June 2009).

> Having a chance to put yourself in the kids' shoes (Interview, July 2008)

In school, due to a change in school policy (possibly as a result of an Ofsted inspection), Cara reported that staff were only to receive internal professional development to reduce the frequency of staff absence.

Although Cara came alone to the sessions, in Year 1 she involved the newly qualified teacher she was mentoring, inviting him to observe her and then trial the outdoor activities. Together they 'feed back in the department INSET for about five minutes (this is all the time we had)' (Interview, June 2009). No further action with or by department colleagues was commented on.

Cara felt it was disadvantageous not having a school colleague to work with on the programme,

> I think it might have encouraged me to make it more of a priority – and just again learning from other people's experiences, if they've been trying it as well, what works well and what doesn't. I know we shared that idea in the CPD anyway, but within our school there's obviously differences between how we would do things and other schools do things, and how we order equipment, and how we can use lesson time, so I think that would have helped, definitely. (Interview, June 2009)

Finally, of all the case study teachers, Cara was the only participant to complete her journal. Unprompted, she commented on its value – seeing it as a prompt and also a place to accumulate evidence,

> And the fact that you'd gone to the trouble of giving us those notebooks to write everything in as well, and I wanted to have something written in it by the time I came to see you again. I think that did encourage you to try it out, yeah. (Interview, June 2009)

6.6.6 Summary

Cara's beliefs concerning learning were in line with those underpinning the programme's pedagogical framework, that is, social constructivist. She was able to offer a broad range of reasons as to why learning outside was beneficial to students – from it being fun to developing a more holistic understanding of the environment. However, the frequency of her practice was limited in terms of the number of lessons and the amount of time she spent outside. Lack of practice limited her implementation of the programme's framework. Her teacher efficacy was undermined by the prospect that students would behave poorly.

6.7 Case: Tom Peterson

6.7.1 Background

Tom Peterson was an early career teacher completing his pre-service training in 2003. Since graduating he had taught in two schools, joining Lady Veronica Girls' School in September 2007 – the same year the programme commenced. Tom was in charge of Key Stage 3 Science. As Tom's first degree was geography, he had completed an extended science PGCE (with chemistry specialism). Prior to the professional development programme, Tom had limited experience of teaching outside, and having recently arrived in London, had limited knowledge of the immediate vicinity surrounding the school. Zara, a colleague who was a biologist with one year's teaching experience, accompanied Tom on the professional development programme, choosing not to continue in Year 2. Tom had no previous CASE experience. When asked about AfL, Tom referred to the frequency of summative testing and the pressure presented by the school's two-year Key Stage 3 (Year 7 and 8) policy and the requirement for him to produce APP (Assessing Pupils' Progress) activities.

Similar to St. Patricia's, Lady Veronica Girls' School was a large comprehensive faith school situated in inner London. In 2008 Year 11 students achieved 83% five GCSEs graded A*-C. In 2007, Ofsted graded the school as 'outstanding'. Centrally situated, the school had very limited grounds consisting of a small Astro Turf playground with many planters. The school had access to a large public park – ten minutes walk away. Prior to Tom and his colleague joining the school, the science department had been involved with the London Outdoor Science programme. Hence, as new staff members, the head of department had recommended they attend the programme. I had a good professional relationship with Tom, although it was limited due to his decreased engagement in Year 2.

6.7.2 Beliefs

A discord was identified between Tom's beliefs concerning learning and those underlying the theoretical framework. That is, although Tom was interactive in his approach, he was predominantly authoritative in that the students were required to find the correct answer. Although not explicitly articulated, his teaching approach suggested some underlying behaviourist/traditional beliefs. Tom's beliefs about why science was taught in schools might be considered narrow and perhaps limited: 'to help develop enquiry skills, investigative approaches, to develop the scientists of the future' (Professional information, June 2009).

Tom maintained the belief that teaching outside increased his repertoire, offering something novel and a 'treat':

> I think it's really useful because it gives you different ideas, different ways to teach. Even if you don't do it exactly as it's shown when you go on the course it can give you – ooh, actually I can modify that a little bit, and I can do that in the classroom, I could do it in the playground, I could do it a little bit like this, you

> could merge two together. It gives you more ideas. When you are a new teacher you don't know first of all, you are clueless – oh I don't know how to do this. And then once you are a little bit older, once you've got a year or two's experience then you are like – yeah, I know how to do this. When there's plenty of other ways to do it, or new ideas that somebody else has come up with, so it expands your… (Interview, July 2009)

Furthermore, he believed that learning outside would be more engaging for his students. However following several negative experiences outside, for example, equipment not working and poor student behaviour, and a change in school policy concerning administrative requirements prior to taking students off-site, he did not seem committed to his articulated beliefs – that is, no teaching occurred outside the classroom during Year 2.

6.7.3 Teacher efficacy

Tom's teacher efficacy and RPTE were moderate for Year 1 – he had a confidence score of 6.5 to teach the activities. In Year 2 his teacher efficacy was considered to remain moderate. For example, he responded to the question what skills have you developed on the programme by saying, 'More confidence about going outside with a whole group of pupils' (Session evaluation, Oct 2008).

However, the RPTE for Year 2 was considered as moderate-low. This slightly lowered judgement was due to two related factors. First, although Tom spoke about feeling more confident and believing the practice to be important, he does not teach any lesson outside during Year 2 and only attended session 4. Second, although in the second person, he articulated a belief that going outside was additional work where 'you are not in your safety zone' and 'you've got less back-ups and there are more things that can happen' (Interview, July 2009).

6.7.4 Implementation of the programme

Tom's implementation of the programme was judged as 'moderately successful' in Year 1, and like Cara, although unlikely to change due to his lack of practice outside during Year 2, no judgement was made due to the lack of lessons observed. Reviewing each of the principles of the pedagogical framework, group work was noted by Tom as an important, but challenging, skill to develop in students. Observed as having organised 'outdoor groups', the condensed episode below illustrates how his practice of 'rule setting' might be considered superficial:

Tom: What shouldn't you do in the park?
Student 1: Don't bother the kids
T: There is water. What are you not going to do?
S2: Go in the water.
T: What are you not going to do in the shop?
S: Hmmm
T: Buy anything!
(Observation, May 2008)

Tom did not ask students to discuss group rules, and when outside, groups were not asked to reflect on the rules set in the classroom.

Tom had interpreted cognitive challenge to mean finding evidence outside for the phenomena explained in the classroom. This approach was in line with traditional teaching and a realist epistemology – in that knowledge was not being constructed, rather students were told explicitly what to observe before observing it. Saying that, where the challenge was explicit in the activity, that is requiring limited teacher input, for example the Egg box activity, Tom seemed surprised (but pleased) as to the quality and quantity of student discussion in response to the open-ended task.

Asked what he might stress to colleagues to ensure effective teaching of the activities, Tom responded: 'the type of questions they need to ask' (Interview, July 2009). However, this was followed by the rationale that the questions were a tool so the teacher could get students to observe 'what they want them to see' (Interview, July 2009). The extract below reflects Tom's closed questioning technique,

T: why are the arrows shown like this?
S1: one is negative and one is positive.
T: Right I can see what you are saying. So it shows…?
S2: Shows that they are equal.
T: Good, yes they are balanced.
(Observation, May 2008)

Tom was not seen to develop student observation skills and struggled to remember the session where the activities to help develop these skills were discussed. Although Tom spent an extended period outside, the majority of time was spent data collecting or travelling to and from the park (total of 80 minutes of 110 minute lesson) rather than teaching. Tom viewed his role outside as a facilitator:

> I think in the classroom you are in control, you are the boss, and then outside it's as if you become just like a site manager, and you have all these little teams getting on with what they are supposed to be doing. And they could be over here, and another group could be somewhere else, and you've just got to oversee them, you are not actually completely directing everything they are doing. Each little group will have their own group leader, and they will be managing themselves more effectively, and being managed directly. (Interview, July 2009)

6.7.5 Influential programme strategies

Tom's engagement in the programme was considered moderate during Year 1 and low during Year 2. Attending all the sessions during Year 1, Tom liked discussing ideas with colleagues from other schools – an activity he considered unique compared to other professional development programmes. Ideas from colleague discussions and from the teacher presentation – such as management techniques – were implemented into his practice. Of the four activities trialled in school, all had been modelled during the programme sessions. Working with a colleague from school was considered mutually beneficial. His colleague, whom he considered less confident to work outdoors, originally triggered them into trialling their first activity at school,

> I think Zara was a bit more apprehensive than me, and I think she was a bit more confident in having a go at things when she'd seen that I'd had a go at it. Or if I said – yeah, I'll come to the park with you. Because I went to the park with one group, and then Zara and myself went together. And I think then she felt more comfortable to do it herself then. And it meant we could talk about it, we could develop resources together. I think having other people that are in the same boat as you makes you do it, otherwise you'd just be like – oh bugger it – I can't be bothered. (Interview June 2009)

It is noteworthy that following his colleague's departure from the programme, Tom's engagement decreased. Tom commented that due to the financial support offered by the programme, his school allowed him to attend the programme.

6.7.6 Summary

A discord was identified between Tom's beliefs concerning learning and those underlying the programme's pedagogical framework – his being more in line with traditional/behaviourist beliefs. Tom offered a narrow range of reasons to learn outside including – novelty and engagement. Tom had an enthusiastic disposition and was initially willing to trial activities. However, although he articulated support for teaching science outside, he reduced the frequency with which he did so – perhaps as a result of lowered teacher efficacy possibly due to a number of difficulties faced when outside and his colleague's departure from the programme in Year 2.

6.8 Chapter summary

This chapter presented six case studies of teachers participating in the 'Thinking Beyond the Classroom' programme. In response to the research questions, the case studies were focused on the teachers' beliefs, teacher efficacy, programme implementation and influential professional development strategies. Table 6-2 presents a summary of each research foci for Year 1 and Year 2.

Table 6-2 Summary of teacher efficacy, programme engagement and implementation

	Year	**Michael Bison**	**Cara Brown**	**Charlie Pence**	**Tom Peterson**	**Megan Thomas**	**Claire Westwood**
Teacher Efficacy	1	High	Moderate-low	Moderate	Moderate	High	Moderate-high
	2	High-moderate	Moderate	Moderate	Moderate	High	High
RPTE	1	Moderate-low	Moderate-low	Moderate	Moderate	High	Moderate-high
	2	Moderate-low	Moderate-low	Moderate-high	Moderate-low	High	High
Programme Engagement	1	Moderate	Moderate	Moderate	Moderate	High	High
	2	Low	Low	High	Low	Very High	Very high
Programme Implementation	1	Moderately successful - Unsuccessful	Moderately successful	Successful	Moderately successful	Very successful	Successful
	2	Unsuccessful	No obs	Very successful	No obs	Very successful	Very successful

(Data range: Teacher efficacy and RPTE: Very low, low, moderate, high, very high; Programme engagement: Very low, low, moderate, high, very high; Programme implementation: Unsuccessful, moderately successful, successful, very successful.)

See Appendix 21 for an extended comparison of the participants in Year 1 and 2.

By comparing the case study teachers' backgrounds, they were considered early-mid career professions – their experience ranging between two and eight years – having taught in one or two schools. Four of the case study teachers had responsibility for a 'key stage' in science, enabling them to develop the department's schemes of work. The case studies reflected the range of science specialisms – that is, biology, chemistry and physics – whilst presenting a range of experiences in teaching science outside prior to the programme. Noteworthy was Megan and Cara's contrasting experiences of teaching outside, both biology specialists, it might be anticipated they would have equal amount of pedagogical practice. All six teachers had chosen to be involved in the programme, however in several cases, heads of departments had prompted engagement, whilst others were stimulated to become involved due to former relationships with King's.

A final comment can be made about the comparison of case study teachers' schools. For example, located across London, the teachers' school grounds were wide ranging – from small concrete areas with decorative planters to acres of land including woodlands and ponds. Furthermore, although four of the five schools were girls' only church schools, their GCSE attainment ranged between 50% - 90% 5 A*-C's and their Ofsted rating ranging between 'satisfactory' to 'outstanding'. Hence, this research had no 'type' of school, and although accepted that contexts at the meso-level influence teachers' decisions (see Chapter 2), central to this study is how, and to an extent why, the individual science teacher makes the choices they do related to their belief system. So whilst being mindful of the case study teachers' contextual differences, Chapter 7 will address the research question: What is the interplay between teacher beliefs, teacher efficacy and pedagogical practice? To this end, through a cross-case comparison, the chapter draws on each of the case study teachers, presenting emerging themes. Chapter 8 will continue the comparison by analysing the professional development strategies considered influential on the case study teachers.

Chapter 7 Beliefs, Teacher Efficacy and Pedagogical Practice

7.1 Introduction

This chapter addresses the research question: 'What is the interplay between teacher beliefs, teacher efficacy and pedagogical practice?' In Chapter 3, beliefs and teacher efficacy were identified as being two of the many constructs which make up a teacher's belief system (Wheatley, 2002). Although other constructs, such as attitude and motivation, could be used, confidence or teacher efficacy, frequently emerged in the literature as a pivotal determinant as to how, if at all, teachers used the outdoors for learning (Glackin, 2006; Nundy *et al*., 2009). Similarly, the teacher development literature has reported a relationship between teachers' beliefs and their practices (Borko and Putman, 1996; Wheatley, 2005).

Using a cross-case analysis, this chapter presents themes that have emerged related to beliefs and teacher efficacy. The first section of this chapter will focus on the belief/practice interplay, before turning to the teacher efficacy/practice interplay. Drawing on earlier sections (7.2 and 7.3), Section 7.4 explores the interrelationship between belief, teacher efficacy and pedagogical practice.

7.2 Beliefs/practice interplay

Both teachers' general beliefs and those more specific to the study's context emerged as influencing practice. The 'general' teacher belief was concerned with how children learn. More specific beliefs concerned: outdoor learning; outdoor teaching; science disciplines; science epistemology; the purpose of science education; and, student behaviour. For the majority of the beliefs, the findings could be divided into two groups: those teachers considered to have been successful to very successful in terms of programme implementation and those having moderately successful to unsuccessful programme implementation – where success was judged on the implementation in practice of the pedagogical framework (see Chapter 5 for an explanation of the methods and Table 6-2 for a summary of case study teachers' practice). The former group will be referred to as *more successful* implementers and the latter group as *less successful* implementers.

Focusing on the latter part of the programme (Year 2), in terms of teachers' implementation, Megan, Claire and Charlie were identified as *more successful*, whereas

Michael was categorised as *less successful* (Table 6-2). For Tom and Cara, Year 2 observation data were not available. However, both were tentatively classified as *less successful*. This inference was made for three reasons. Firstly, both teachers' practice was considered moderately successful during Year 1, as was Michael's. Secondly, both teachers trialled very few outdoor lessons (Table 6-1), and therefore, practice was less likely to improve. Finally, on a related point, like Michael, both Tom and Cara's programme engagement during Year 2 was identified as low (Table 6-2). Hence with caution, I argue that change in practice during Year 2 was unlikely.

7.2.1 Teachers' beliefs: how children learn

In Chapter 3, I argued that the belief/practice relationship was bidirectional. That is, as Pajares (1992) asserted, teachers' beliefs influence their pedagogical choice whilst, as Guskey (1986) postulated, practice outcomes shape related beliefs. However, belief change is slow and requires multiple, rather than one-off, attempts at practice to be able to observe the outcomes (Guskey, 1986; Mischel and Shoda, 1995). Hence, for those teachers who are practising pedagogy incongruent to their beliefs about learning, multiple attempts at the new pedagogy might be necessary for belief change. This persistence in using a pedagogy in conflict with one's beliefs, I assert, might feel unnatural, difficult and time-consuming with regard to planning.

The professional development programme this thesis is studying was constructed on the belief that students learn by means of social constructivism underpinned by a theoretical framework arising from the theories of Vygotsky and Piaget (described in Chapter 4). A relationship was identified between the beliefs that underpinned the design of the programme and those held by the teachers about learning. How similar teachers' beliefs were to those that informed the programme influenced their pedagogical approach. It also influenced the likelihood that practice outside might change. Hence, Charlie, Claire and Megan (previously identified as using social constructivist teaching approaches) were considered *more successful* in programme implementation. For these teachers, a positive change was observed in their practice over the programme's duration. Conversely, for Michael and Tom, identified as having beliefs and teaching strategies with greater affinity with behaviourist/traditional approaches to student learning, implementation was identified as being *less successful*. Bell and Gilbert (1996) similarly reported this relationship – that successful programme implementation related to how aligned teachers' beliefs were with those informing the professional development programme. For example, whilst Michael attempted to engage with the professional development programme by attending the sessions and trialling the activities, the following statement reveals that he progressively found the process more challenging:

> I thought last year [Year 1] it ran really well, and they [the sessions] were interesting, and then this year it seemed to sort of trail off a little bit, and there weren't so many new ideas coming up, so it seemed to have lost a bit of momentum.
> (Michael, Interview, July 2009)

The statement correctly captures the nature of the programme in that Year 1 saw sessions concentrate on specific, concrete and practical ideas that relate to day-to-day classroom operations (Fullan and Miles, 1992), whereas Year 2 brought a substantial shift towards pedagogical techniques and reasoning. In Year 1, for example, when an activity was presented which was aimed at developing students' group work whilst outside, the same activity was used the following year but the emphasis was on the development of teacher pedagogy to enhance students' collaborative learning and develop richer dialogue. That is to say, in Year 2, the programme tutors focused on pedagogical instruction rather than on the 'supporting' activity. Hence, due to the incongruence of Michael's beliefs concerning learning with those of the programme, a sense of pointlessness arose towards sessions that were attempting to advance social constructivist approaches during Year 2, leaving Michael's practice unaltered.

Beliefs concerning how students learn, I argue, have emerged as an important influence on teachers' responses to the programme. Furthermore, as the following sections illuminate the findings suggest that beliefs about learning had a wide bearing on other beliefs. To use Rokeach's (1968) analogy – that beliefs are organised along a central peripheral dimension – teachers' beliefs concerned with student learning might be considered closer to the 'core'. If this was the case, then their influence on more peripheral beliefs, for example how children learn outside, could be understood. It would also explain why such beliefs have been described as extremely challenging to alter (Ajzen, 1998).

Hence, as a pattern emerged that suggested a relationship between teachers' beliefs concerning how students learn and their pedagogical practice, other beliefs were simultaneously at play. For example, this complexity of beliefs was observed in Cara's case study where, although her teaching approach was aligned with social constructivist beliefs, her programme implementation was identified as moderately successful. The following three sections explore beliefs related to the outdoors – the context of focus for the professional development programme.

7.2.1.1 Teachers' beliefs concerning learning outside

Table 7-1 summaries the case study teachers' beliefs concerning teaching and learning outside when grouped as individuals holding social constructivist or traditionalists/behaviourists beliefs. The beliefs listed were expressed over the two years of the programme. Appendix 22 and Appendix 23 compare individual teacher beliefs for teaching and learning science outside for Year 1 and Year 2.

Table 7-1 Beliefs concerning teaching and learning outside for teachers holding social constructivist or traditional/behaviourist beliefs

Teachers' beliefs concerning learning	Beliefs about **student learning** outside *Students will…*	Beliefs about **teaching** outside
Social constructivist *(Generally more successful implementation of programme)*	…develop generic skills e.g. group work, discussion. …have increased ownership of tasks. …increase their awareness of the surrounding environment. …develop the ability to transfer **science** knowledge to different contexts. …have greater understanding of the natural environment.	Students need to be taught explicitly how to work outside. Planning is essential; so is flexibility.
Traditional/ behaviourist *(Generally less successful implementation of the programme)*	…have fun and be more engaged. …transfer classroom taught science outdoors.	Teaching outside is novel and a treat; it offers variety. Behavioural issues will result. Support-staff are essential; often difficult to get. Limited 'good' science examples are found in school grounds. Increased planning and administration; time is a factor. Things can go wrong and 'back up' is not at hand.

Table 7-1 suggests a relationship between the beliefs teachers hold, generally, about how children learn and those more specific concerning teaching and learning outside. In terms of student learning outside, teachers with social constructivist beliefs, and generally *more successful* programme implementers, such as Megan and Claire, believed the outdoors offered students authentic opportunities to develop generic skills such as working in groups and discussion. Generic skill development was related to the openness of tasks which included the wide range of examples which ensured that students spent more time in discussion with one another. Megan's response, below, illustrated several of these beliefs, that is, students learning group work skills and how these skills differed depending on the context.

> I: To date what would you say were the main outcomes of the programme?
>
> Megan: I think the emphasis is on group work and getting them used to communicating with different people in different ways and in different environments as well. Changing everything about where they were communicating, and therefore how they had to, as it is very different than when you are sitting next to the person in the classroom having a discussion, to if you are outside trying to get a group together that have gone off to do different things. So it [being outside] actually worked on the children's behaviour management and not so much on the teachers, it was almost, 'can they manage themselves in a different environment?' Because they are out there they have got a task to do and if they don't do it, they don't get the information to feedback to the class, so they look stupid.
> (Megan, Interview, April 2009)

In addition, the extract offers an insight into the potential for development of students' group management skills when increased ownership over their learning is offered; an issue returned to in Section 7.2.4. Teachers who had *less successful* programme implementation appeared not to be concerned with students' generic or practical skill development or increasing student ownership.

Teachers who were *more successful* programme implementers valued students' development of a multidimensional relationship with their surrounding environment by learning within in it (for example, an everyday relationship, a science relationship, an art relationship); *less successful* teachers did not. More specific to science learning, *more successful* teachers valued the opportunity for learners to develop their ability in transferring and developing science knowledge in different contexts. For these teachers, the outdoors was considered a very important starting point as it was seen as a link to the 'natural world'. These beliefs about the outdoors can be aligned with research concerning the role of science practical work. Swain *et al.* (1999) found UK science teachers ranked 'to make phenomena more real' the fourth highest reason to include practical work.

Turning now to consider what teachers with *less successful* programme implementation believed about students learning when outside, this group did not differentiate the learning potential offered by the outdoor context; instead they situated it, more generally, as another learning 'tool', 'resource' or 'opportunity'. Although this group of teachers rated the opportunity higher than other teaching methods, this was due to the potential for 'fun' and being 'a treat' rather than because it provided learning exclusive to the outdoors. *Less successful* teachers did not use the outdoors to introduce students to science concepts. Rather it was consigned to an inferior status of review tasks only; science curriculum learning being entrusted to methods inside the classroom. These sentiments are captured in the exchanges below:

> Michael: Well… it is learning outside as well, and that is the idea of going out. And trying to solidify some of the things that we did inside the classroom. So I wanted to have things inside the classroom first as I felt that gave them a bit of a basis for their understanding… outside. I mean we could have gone straight outside but I think that they would have been less directed and have had less understanding of why things are happening. And why things are happening as they were.
> (Michael, Interview, July 2008)
>
> I: So it was a revisit?
>
> Michael: Yes, it was like a revisit of all that stuff, in quite a fun context, so, you know, to get them really engaged with the topic and to try and establish all those sort of key words, basically, that I've just said.
> (Michael, Interview, July 2009)

There are parallels between the findings above and those within the broader literature concerning practical work (Section 3.3.4.1). The first related point is from Swain *et al.*'s (1999) study which found that 'to arouse and maintain interest' was the third highest ranked reason for the inclusion of practical work. A further similarity is with Donnelly's (1998) finding that the majority of teachers saw practical work as a constitutive element 'of being a science teacher'. Hence the reason for doing practical work was due to it being part of the repertoire rather than a strategy consciously chosen for learning. The former belief, rather than latter, was identified in *less successful* teacher implementers beliefs about using the outdoors.

7.2.1.2 Teachers' beliefs concerning teaching outside

A relationship existed between the beliefs teachers held about students' potential to learn outside (as discussed in the previous section) and the type of teaching they carried out. Hence, Table 7-1 indicates that where *more successful* teachers saw the outdoors as an opportunity for learners to develop a wide range of skills and knowledge, their teaching explicitly incorporated exercises for students to develop these skills in the new contexts. Skills to be taught included: how to observe 'scientifically' and how to work collaboratively. Claire, in the extract below, discussing the Egg Box activity, valued the generic skills students developed over the scientific subject knowledge that students might or might not retain:

> Claire: […] so they [her Year 9 lower set students] probably haven't been given that much responsibility before for extended periods of time, so it is about building up their skills and being able to do it [work outside as a group]; so it was the group work. The characteristics and categorising was much lower down on the list, even though thinking about their exam on Friday, that was quite useful, and I was quite surprised about what they didn't know… well terrifying, but that was not really what I was getting at and it didn't matter to me for the lesson.
>
> I: Okay, so it is mainly group work that, is what you are saying?
>
> Claire: Yes, definitely.
> (Claire, Interview, March 2009)

To achieve these aims for learning, *more successful* teachers recognised that good planning was essential. Alongside a detailed lesson plan, the teachers acknowledged the necessity for built-in flexibility where prior consideration of alternatives had occurred. Planned alternatives included: consideration of a range of working sites if areas were not accessible; prepared site examples (especially where seasonal variation occurred); and adaptive learning objectives (when an aspect of students' knowledge/skills required strengthening or an opportunity for learning arose through a unique outdoor example).

Where *more successful* teachers' beliefs about teaching outside might be considered as solution focused, *less successful* teachers' beliefs, presented in Table 7-1, were dominated by anticipated shortcomings. For example, the need for support staff and associated problems of acquiring them, the potential for mishaps with no easy backup plan and the limited science examples that might be found outside.

One exception to the dominant list of beliefs concerned with shortcomings was when teachers with *less successful* programme implementation said teaching outside offered something novel, a treat or an opportunity for variety (Table 7-1). Perhaps, as Carson *et al.* (2001) suggest, by offering something novel, these teachers believed that students' curiosity and motivation to learn would ensue. However this outlook, I suggest, is naïve, and the potential source of the multiple beliefs held by the *less successful* teachers concerned with shortcomings (rather than potential affordances) of teaching outside. This conjecture, that novelty is an issue, is founded on the notion that it can become a distraction. As Falk *et al.* (1978) found, students' lack of preparation and their excitement resulting from the anticipation of the treat led to an inability to concentrate. The result was reduced student learning and increased behavioural issues. Consequentially, *less successful* teachers' beliefs were borne out: behavioural issues did result when students were taken outside (Table 7-1); an issue returned to in Section 7.2.4.

Related to the naïve belief that novel contexts will solely hold students' attention, teachers appeared to underestimate the amount and type of planning required to teach outside. However when (eventually) *less successful* teachers identified the necessity to plan differently, it was often considered time-consuming and a chore rather than an opportunity for successful science learning. Tom, judged as having *less successful* programme implementation, experienced an episode outside where the equipment failed. No alternatives were in place and, as a result, students behaved poorly (Observation, Tom, July 2008). Although he went on to teach outside on one further occasion during Year 1, no further attempt was made during Year 2. Tom describes this difficult episode in the following interview extract at the end of the programme:

> I: What do you think the main goals were of this PD programme?
>
> Tom: I think a lot of it was to get people to not be scared of leaving the classroom. Because it is a bit more work and there are more things that can go wrong, and you are not in your safety zone, oh well, if any of my equipment breaks down I can just put a video on, or I can just do this or do that. You are outside and you've got less back-ups and there's more things that can happen. So I think that puts quite a lot of people off, and some people aren't comfortable, as well, being outside.
> (Tom, Interview, June 2009)

Tom did not acknowledge that the scenario he presented had happened to him. This omission might be simply due to a memory lapse, or might be due to teacher efficacy, a point returned to later (Section 7.3). However due to the low number of outdoor lessons taught, he did not have an opportunity to develop any alternative teaching strategies – as he has inside – and was unable to move on from the negative experience.

7.2.1.3 Teachers' belief change concerning learning and teaching outside

Beliefs are difficult to change (Ajzen, 1998) and changes are often small and incremental. This sentiment was borne out across the majority of the case study teachers; however change was not always in a positive direction (Appendix 22 and Appendix 23 present a comparison of teacher beliefs for teaching and learning outside for Year 1 and Year 2). Claire and Tom illustrate two contrasting outcomes. Claire, who had initial reservations about teaching science outside due to her belief that the context was for ecology teaching only (described in detail in the following section), acknowledges that she changed her opinion during Year 2. Whereas, Tom (who, like Claire, had limited experiences of teaching outside but embraced the opportunity), as discussed in the preceding section, came to reject the context for teaching.

In terms of an explanation for the differences, Tom's negative experience may be partially responsible. However, Claire also encountered challenging student behaviour. Hence, I postulate that the differences between the teachers' direction of belief change was associated with their belief concerning how children learn, as discussed in Section 7.2.1. Claire believed that children learned through social constructivist approaches and gradually found the outdoors more amenable to this philosophy than the classroom. Claire articulated two reasons for her belief. First, premised on the understanding that social constructivism necessitates group work (Shayer and Adey, 1994), Claire noted the outdoors presented a less restrictive space compared to the classroom: being 'outside in one of the little huts' saw a richer discussion develop than when in the classroom (Claire, Interview, May 2009). This decline in restrictions might be explained both physically and mentally. Physically, taking Foucault's (1977) principle of the 'enclosure', the classroom generally prioritises the need to 'break up collective dispositions' (p.143) over collaborative learning which is done through the use of organised seating. Whereas the outdoors, it could be argued, without fixed tables, chairs and seating plans, was more encouraging of student interaction and talk. Mentally, taking Bernstein's (1990; 2000) idea of regulative discourse, described as management to establish order, relations and identity, the outdoors offered students an opportunity to acquire a different identity, or a new role as a learner. Explained further, many of the learnt routines of being in the classroom are no longer appropriate and new ones are underdeveloped; for example, teacher-student hierarchy, to an extant, is initially removed, due to the omission of artefacts such as the teacher's desk and the 'front of the classroom'. Hence learners are challenged to adopt 'new' roles.

A valid opposing perspective to that proposed above is that, rather than the outdoors *per se,* any learning context other than the classroom has the potential to provide a greater opportunity for social constructivist learning. However Claire's second reason for believing social constructivist approaches are more amenable outside the classroom is specific to the outdoor environment. That is, the context was thought to offer authentic cognitive challenge – an important component for constructivist learning (Shayer and Adey, 1981). This point is evident in the extract below, where Claire discussed the 'Forces all around us' activity:

> I: What do you think the pupils gained from going outside?
>
> Claire: I think they were surprised by what they were seeing [...].
> But they were outside they were confused, the leaves were sometimes still and sometimes moving, and moving back and forth, but at different speeds, and the whole bluebell, but one's on the ground and one's not, different parts of the same object will have different forces acting on them. So those sort of surprising things they wouldn't have come up with in the lab. They would have come up with stereotypical, an aeroplane taking off, something landing, something stationary, and going outside they were surprised by what they were seeing.
> (Claire, Interview, May 2009)

In contrast, Tom's predominantly authoritative/didactic approach led him to reject the opportunity to teach outside following his negative experiences. Entwined in beliefs about how children learn are teachers' beliefs about what they consider science to be and the role of science education. Issues surrounding science disciplines, science epistemology and aims of science education are taken up in Sections 7.2.2 and 7.2.3.

Charlie also underwent significant belief change concerning teaching and learning outside. Charlie originally held the belief that the outdoors offered science teaching, 'pedagogical variety', 'novelty' and a 'source for data collection'. Whereas Charlie's implementation of the programme during Year 1 was considered *successful* (Table 6-2), for other teachers sharing these sentiments, their implementation ranged from moderately successful to unsuccessful. However Charlie's beliefs changed during Year 2, becoming more in line with those held by the *more successful* teachers – Megan and Claire. For example, in Year 2 he spoke about the value of the outdoors as a resource that offered challenge and opportunities to learn about the natural world; his implementation of the programme during Year 2 being judged as rising to very successful.

Why was it that Charlie's beliefs changed and his pedagogy improved whereas Michael's and Tom's, who held similar beliefs about what the outdoors offered science teaching during Year 1, did not? Multiple reasons are probably at play. Concentrating only on teacher beliefs, several differences between Charlie, Tom and Michael are apparent. First, there was congruence between Charlie's original beliefs about learning more generally and those of the programme (see Section 7.2.1). Second, Charlie's programme implementation during Year 1 was considered successful, unlike Tom and Michael, who were considered as *less successful,* which may have led to him observing student outcomes more in accordance with those discussed within the programme sessions thus enabling him to refine his beliefs. Third, Charlie worked alongside a senior colleague (Claire Westwood) who was judged to have successful practice in line with the programme; Tom and Michael did not. However, this final point regarding Claire's (a chemist) support of Charlie (a biologist) was of interest as their subject specialism were the opposite of what would usually be expected, in that biologists might be more at home teaching outside the classroom. The potential influence that subject specialism has on beliefs concerning teaching outside is discussed below.

7.2.2 Teachers' beliefs: science disciplines

Learning outside the classroom is usually associated with teaching biology and more specifically ecology (Gayford, 1985). This belief is perhaps a result of the natural history movement, which preceded the teaching of biology in schools, leaving a legacy of field study centres where learning about biodiversity and data collection methods were core. Associated with this belief is an expectation that biology teachers will be more inclined, experienced and able to use the outdoors for teaching – compared with teachers of the other sciences; a notion inferred from the majority of research reporting on biology/ecology field work rather than science (for example, Barker *et al.*, 2002). Beliefs associated with subject alignment and teacher expertise may influence whether teachers feel they can teach outside the classroom. In the extract below, Claire (a chemist) reveals that, prior to the programme commencing, her beliefs were similar to those above. She declared that these beliefs did inhibit her using the outdoors:

> I: Is there resistance from your department to using the outdoors?
>
> Claire: I don't know. For some people it would have just never occurred to them. I don't think it is a resistance, it's more a 'oh I wouldn't have thought of that' […]

> We've got some new biology teachers this year, well they are biology trained and they are teaching Key Stage 3 ecological relationships and the first time in ages that I have seen people doing quadrats outside on the daisies and on the grass and they just took that up on themselves to do, 'Oh I'm teaching ecological relationships of course I am going to use the outside space and do quadrats and do group work'.
>
> Now thinking of it in terms of group work I am not sure that they [the biology teachers] would have put those two links together but because of how they've been trained and what they've always done that's second nature to them: they would choose the outdoor space and use it. I don't know if that is just more of a shift as there are just more biology teachers who are more used to that, because actually within the department teaching at Key Stage 3 there is only me who is a non-biologist everyone else who teaches Key Stage 3 is a biologist. So, I maybe the one who has got the resistance in terms of where I have come from in terms of outdoor space because as a chemist I've never, I've not done fieldtrips and that sort of thing. Where the rest of them are trained like that.
> (Claire, Interview, March 2009)

In addition to subject alignment, the above extract reveals Claire's belief that biology teachers are more able to teach outside due to their former training. The type of training is not clear: whether degree qualification, teaching qualification or both. That said, over the duration of the programme, Claire's beliefs altered. She came to associate teaching outdoors more generally with science and acknowledged that a wider range of teaching skills were required; skills identified as transferable from her classroom teaching. As a result of Claire's new awareness, she re-evaluated biology colleagues' use of the outdoors.

Claire aside, no other case study teacher held the belief regarding biology/outdoors alignment advanced above. Going further, the claim might be considered to be challenged by Cara, a biologist, when she described herself as someone who, 'shied away from taking kids outside' (Cara, Interview, July 2008). Furthermore, Megan, a biologist, who, like Claire, had very successful programme implementation, did not accept that teachers across the sciences lacked training. Instead, she felt that all teachers possessed the required skills to bring students outside; something Claire was only coming to realise towards the end of the programme. Megan did not think that the outdoors had a particular alignment to a specific science, although she understood why people held a biology/outdoor association. To justify these beliefs, Megan described her department's ability to use the outdoors across multiple subject areas:

> Megan: Yeah. […] But with ecology, we've always gone out there. It has never been a 'Oh we better go out', it has always been a standard thing that people would go out into the grounds. For photosynthesis we often go out and use light meters and things so we often do that. So lots of people do go out anyhow, for the rocks and weathering we always go out and look at different parts of the building and stuff,

> it's in the scheme of work so things like that we often do. And respiration, they always go out and run around the running track.
> (Megan, Interview, April 2009)

This particular extract provides an example of a collective belief. That is, according to Megan, the department believed that learning outside held equal validity as learning inside the classroom.

A final point concerning teachers' subject specialism and the outdoors relates to the choice of activity. This choice relates not only to teachers' beliefs but involves teacher efficacy (returned to in Section 7.3). For both Michael and Charlie, their science specialism was, to an extent, responsible for the initial choice of activities trialled during Year 1. Although Michael, a physicist, trialled four activities (see Table 6-1), he most frequently used the 'Rose-tinted glasses' activity (a physics-related activity). Charlie, a biologist, trialled a broad range of activities in Year 1 (n=6), although he said he felt more comfortable in completing the biology-related activities.

No definite picture has emerged concerning the relationship between teachers' subject disciplines and teaching outside. In the next section, I explore teachers' subject specialisms further by considering their science epistemology and their beliefs about the purposes of science education.

7.2.3 Teachers' beliefs: science epistemology and the purpose of school science

Kouladis and Ogborn (1989) identified a mixed picture concerning subject specialist specific science epistemology. However, broadly speaking, the researchers identified biology teachers as being inclined towards realist positions, physics teachers inclined towards relativist positions with chemistry teachers being described as 'eclectic'. Compared to that study, my study involved fewer participants and different research methods, however the reverse relationship was found (Appendix 24 presents a comparison of case study science specialism, science epistemology and belief concerning school science). That is, the physicist (Michael) held beliefs more aligned with a realist position, whereas the biologists (Cara, Charlie and Megan) held beliefs more aligned with a relativist position. These findings support the growing literature, summarised in Chapter 3, that teachers' subject specialism (biology/chemistry/physics) is only one of many factors informing their science epistemology beliefs.

Leaving subject specialism aside, what can be inferred from the teachers' beliefs about science epistemology? Kang and Wallace (2004) claim that teachers' science epistemology beliefs influences their teaching goals and ultimately their practice. To examine this claim a comparison of beliefs about epistemology and goals and actual practice for each of the case study teachers was carried out (see Table 7-2). Mirroring Kang and Wallace's (2004) findings, the two teachers (Tom and Michael) identified as possessing realist science epistemologies were concerned with the transmission of knowledge (purpose of science education) and used predominantly authoritative/didactic teaching approaches. Both teachers were categorised as *less successful* in terms of implementing the programme. However, Kang and Wallace's other finding, that teachers identified as having alternative (relativist) epistemologies were rarely observed to reflect this belief in practice, was not replicated in this study. The two teachers (Megan and Claire) who held relativist epistemologies believed that the purpose of science education was to develop students' generic skills, their understanding of scientific method and the applications to everyday life. In this study, approaches congruent with relativist epistemologies, such as openness to questioning, creativity and extended discussion were observed and the explicit skills required by students to learn within this framework were taught. Both teachers were considered as *more successful* programme implementers.

One possible reason for the difference in findings was that whereas Kang and Wallace observed 'normal' lessons, this study had observed lessons underpinned by social constructivist approaches. That is not to say that Megan and Claire did not usually teach 'normal' lessons as described (I have no data to support this either way) but rather this study reveals that when conditions are favourable, teachers with relativist epistemologies are more able and willing to trial social constructivist approaches outside. However, teachers with realist epistemological positions, who are not normally challenged due to, what Kang and Wallace (2004) described as the narrow view promoted by preordained curriculum and external tests, might gradually abandon teaching the outdoor activities because of the roots in social constructivist approaches which have greater affinity with relativist epistemologies.

Table 7-2 Case study teachers' science epistemologies, beliefs concerning the purpose of science education and teaching approach

		More successful programme implementers			*Less successful* programme implementers		
Case study teacher (Science specialism)		Megan Thomas (Bio.)	Claire Westwood (Chem.)	Charlie Pence (Bio.)	Cara Brown (Bio.)	Michael Bison (Phy.)	Tom Peterson (Chem.)
Science epistemology	Relativist	*x*	*x*	*x*	*x*		
	Realist					*x*	*x*
Purpose of science education	Skills Application Knowledge of scientific method	*x*	*x*	*x*	*x*		
	Content knowledge/ future scientists			*x*		*x*	*x*
Dominant teaching approach	Social constructivist	*x*	*x*	*x*	*x*		
	Traditional/ didactic					*x*	*x*

('x' indicates traits identified)

(See Chapter 6 and Appendix 21 for further specific data on case study teachers).

However, for Charlie and Cara, the relationship described above does not exactly follow. Charlie shares beliefs concerned with the purpose of science education with teachers more inclined towards a realist epistemology. However, perhaps due to his relativist position and the influence of working alongside Claire, who presented a strong social constructivist approach, Charlie's beliefs concerning the purpose of science education shifted, becoming even more focused on developing understanding of the nature of science.

Although Cara's beliefs concerning science, science education and learning were similar to those teachers categorised as *more successful* in programme implementation, her implementation was categorised as *less successful*. As in Charlie's case, other factors appear to have influenced her pedagogical practice. As discussed in Section 7.3, these factors relate to Cara's teacher efficacy in her ability to teach outside and the lack of department/school support (collective efficacy) especially during Year 2 of the professional development programme.

7.2.4 Teachers' beliefs: managing student learning outside

Teachers' beliefs concerning how students should be managed relate to: how they believe children learn, how they believe they should be taught and their judgement of their ability to enact these pedagogical practices. The latter point relates to teacher efficacy, returned to in Section 7.3. The former points, concerning student learning and teacher pedagogy, were discussed in Section 7.2.1. A key finding was that the teachers who frequently used social constructivist approaches were noted to be more proactive (than teachers using traditional approaches) in developing students' skills to work in groups (for example, Megan, Interview, April 2009 Section 7.2.2.1). Megan speculated that the inclusion of group work skills led to a reduced need for her to manage students as they became more able to self-manage.

Transference of teaching approaches from inside to outside the classroom was not automatic for all teachers. For example, Claire, who in Year 1 was identified as holding a 'social constructivist approach: a distinct focus on the collaborative group' (see Section 6.2.4), frequently exhibited strategies more in line with 'traditional approaches' when teaching outside. Claire's practice outside during Year 2 came to reflect her constructivist beliefs as she transferred strategies from inside to outside (for example, seating students outside enabling whole class discussions).

So what might explain teachers' initial use of strategies more aligned with traditional approaches? I postulate that these behaviours are rooted in beliefs concerned with gaining and maintaining order. Claire believed that students 'get distracted from other things that are going on [outside]' causing them to misbehave (Claire, Interview, May 2008). However, her beliefs became less pronounced during Year 2. To explain the relationship between the beliefs and behaviours, this section draws initially on Foucault's (1977) work, before turning to Bernstein (1990; 2000) (as discussed in Section 3.3.5).

Foucault conjectures that schools are concerned with redirecting students' understanding of the do-able and say-able, and, to this end, describes how 'technologies of the social' are used. Relevant to this study is the identification of the *technology* that: 'discipline proceeds from the distribution of individuals in space' (Foucault, 1977:141). For example, he asserted in terms of space and discipline:

> Each individual has his own place; and each place its individual.
> […]
> Avoid distributions in groups; break up collective dispositions.
> […] and, to know where and how to locate individuals, to set up useful communications, to interrupt others, to be able at each moment to supervise the conduct of each individual… (Foucault, 1977: 143)

I conjecture that such classroom practices are implicit for *successful* teachers, such as Megan and Claire. However when an alien 'enclosure', such as the outdoors, was presented, management strategies were often lacking from their repertoire during Year 1 of the programme. Rules and routines for organising students required development, as did knowledge of how to use unfamiliar resources, such as, high steps to stand on and benches to seat students. For example, Charlie expressed an apprehension about managing students outside caused by the unfamiliarity of resources:

> I'm more comfortable inside but it would help if we did do it outside, I think, as the examples are around us easily and we can look at them again, *etc*. I use the board a lot to focus them on ideas, and that isn't there. I think it is more me, and trusting them. Trying to gather their ideas might be difficult; there might be too many distractions. But saying that, they might get over this with practice.
> (Charlie, Interview, May 2008)

Furthermore, the extract discloses Charlie's awareness that new rules, routines and arrangements can be developed with practice. So, Foucault's idea of the enclosure can be used as a theoretical tool to explain why teachers are frequently concerned about managing behaviour outside – due to the novel space, new systems need to be established and shared.

Bernstein's work on regulative discourse (RD) and instructional discourse (ID) can be used to explain why teachers with social constructivist beliefs about learning often used approaches more synonymous with traditional teaching beliefs on entering the new space. Bernstein conjectures that 'the discourse of competence' is embedded 'into a discourse of social order in such a way that the latter always dominates the former' (1990:183). Therefore RD must be enacted first. Rules and comportments for the outside need to be formulated, shared and practised. Something that is implicit in teachers' practice inside needs to become the initial focus outside. Once the RD has been made clear in the new context, the ID can follow. RD has greatest sympathy with behaviourist teaching approaches

– where students are told what, when and how. Hence, Bernstein's theory could explain why a teacher such as Claire defaults to behaviourist approaches before utilising her social constructivist skills.

7.2.5 Summary

The teaching beliefs of the case study participants played an important role in their interpretation of the programme's pedagogical framework. Table 7-3 shows a general overview of the beliefs held by the teachers regarded as either *more or less successful* in the implementation of the pedagogical framework. However the table's generality should not be overlooked. Teachers, such as Cara, had beliefs that did not fit with the expected pedagogical practice implementation. Reasons for this mismatch include teacher efficacy, which Section 7.3 considers.

Table 7-3 Beliefs of teachers with more or less successful programme implementation

Belief type	***More successful* implementation of programme pedagogical practice**	***Less successful* implementation of programme pedagogical practice**
Beliefs of learning	Social constructivist	Behaviourist/traditional
Beliefs about learning outside	Offers learners authentic opportunities to develop generic skills Offers learners opportunities to develop multidimensional relationship with outside environment	Offers learners 'fun' opportunities It is a treat
Beliefs about teaching outside	Detailed planning with built-in flexibility is essential	Limited planning required as the context's 'novelty' will hold learners' attention
Belief about subject discipline	All science disciplines can be taught outside	*No comparison*
Science epistemology	Relativist position	Realist position
Belief about the purpose of science education	Skills application Knowledge of scientific method	Content knowledge Future scientist

Beliefs about managing students outside	Pedagogical choice dictates management strategies	Management strategies dictate pedagogical choice

That aside, Table 7-3 enables a comparison between the beliefs of two groups of teachers from which similarities between beliefs for each can be identified. Where teachers *more successful* in implementing the programme were found to have social constructivist beliefs about learning they also had similar beliefs, such as those concerned with learning outside (for example, it offers learners opportunities to develop multidimensional relationships) and those concerned with the purpose of science education (for example, knowledge of scientific method). In comparison, teachers *less successful* in implementing the programme had behaviourist/traditional beliefs about learning and were considered having a narrow belief about learning outside (for example, it offers learners a treat), whilst their belief about the purpose of science education focused on content knowledge and capacity building for the sciences.

Rokeach (1968) and Ajzen (1998) discuss the connectivity of beliefs (see Chapter 3). They proposed beliefs to be ordered along a peripheral dimension – some being closer to the core than others. By using this model, I conjecture that it might be inferred that, in this study, teachers' beliefs about how children learn are central and highly connected to other teacher related beliefs.

7.3 Teacher efficacy/practice interplay

This section explores the interplay between teacher efficacy and pedagogical practice. As in the preceding section, a relationship between teachers' practice – categorised as *more* or *less successful* in programme implementation – and the level of teacher efficacy emerged. To explain the relationships between teacher efficacy and practice, it will be necessary to consider particular beliefs held by the teacher. Not to do this would leave the teacher efficacy/practice relationship lacking explanation. However, Section 7.4 considers the multi-variable relationship further.

7.3.1 High teacher efficacy: *more successful* programme implementation

Megan and Claire were judged as having high teacher efficacy and were successful in implementing the programme (Table 6-2). The following extract taken from the end of

Megan's lesson exemplifies *successful* practice in that it captures open questioning, challenging ideas within the outdoor context:

> **Sharing and Challenging ideas/Linking ideas together and reflection**
> Megan gathered students on grass under tree
> Asked questions/engaged students in discussion, likely to (and seemed to) encourage reflection – asked open-ended questions, built on students' responses, but also scaffolding them towards particular points (again, particularly necessary with this group)
> For example -
> Megan: Who thinks the place they went to is a good habitat and why?
> Girl defined 'good habitat' as one where not many people go – Megan explored this – if spread out, will get different areas, where there might be different species, different kinds of things from other areas.
>
> Megan: How can thinking about what things eat support what she (student) said?
> Thinking about evidence...
> Range of responses from students
> Megan helped them see that different animals eat different things, so will be found in different areas (where their particular food can be found).
> (Megan, Observation, June 2008)

Megan and Claire were also found to have 'high', increasing to 'very high', engagement levels over the duration of the programme; exemplified by the frequency and range of activities taught compared to other case study teachers (Table 6-1). Woolfolk Hoy and Davis (2006) highlight the cyclical relationship between the factors: teacher efficacy, pedagogical practice and programme engagement. Where the influence from one factor on another starts and ends is difficult to ascertain. In concordance with research findings (for example, Haney *et al.*, 1996, Pajares, 1996), Megan and Claire, who were judged to have high teacher efficacy during Year 1, put a great deal of effort and time into organising and planning programme activities – persevering when obstacles were presented. Echoing Tschannes-Moran and Woolfolk Hoy's (2001) findings, both teachers experienced raised student engagement in lessons following the implementation of the programme framework. These positive outcomes maintained their high level of teacher efficacy, contributing to their continued engagement with the programme.

It is worth noting that neither teacher's efficacy was judged as very high. Both expressed some form of doubt or fear. For example, Claire originally questioned her ability to teach outside due to her background in chemistry which had not prepared her for using the outdoors (see Section 7.2.2). Megan queried her status as a CASE 'expert', referring to it as 'bizarre', believing that aspects (for example questioning skills) can always be improved 'as you are never perfect' (Megan, Interview, April 2009). Wheatley (2002, 2005) postulated that admissions of doubt and uncertainty provide conditions that engender teacher change. Settlage *et al.* (2009) concurred, asserting: 'Vulnerability is not necessarily negative. Self-doubt is not an incapacitating force, but may promote reflection and revision of practices […]' (p.118).

Wheatley (2005) explained that for doubt to be beneficial, teacher efficacy needed to be low in a specific aspect of teaching rather than a global condition. Teacher efficacy specificity was true for both Claire and Megan. Uncertainty, described as 'disequilibrium' in teachers' thinking, is the realisation that current knowledge and skills are insufficient for the new situation (Jones and Nimmo, 1999). Lange and Burroughs-Lange (1994) suggest that the state of uncertainty acts as the motivation to change practice with a goal to feel 'more comfortable with what they knew and did' (p.627). Southerland *et al.,* (2011a) refer to this internal affective response concerning practice as 'pedagogical discontentment'.

So, for Claire and Megan, due to their high global teacher efficacy but low specific practice related teacher efficacy, a disposition of pedagogical discontentment arose. This process led to 'a state of cognitive conflict' which evoked the recognition that there was a 'mismatch between […] science teaching pedagogical goals and *classroom* practice' (Southerland *et al.,* 2011b: 299). If, however, the teacher efficacy had been very high, there might be limited reflection on practice, resulting in pedagogical contentment, leading to stasis. Conversely, if teacher efficacy, specific and global, had been low, though pedagogical discontentment might have been evident, the general lack of self-efficacy might have been disabling.

With reference now only to teacher efficacy specific to teaching science outside, at the end of the programme, Megan and Claire's teacher efficacy and practice were judged as high and very successful. However, it was Claire's teacher efficacy that altered significantly over the two years from moderate-high to high. Using the RPTE framework, a relationship is evident between Claire's doubts and beliefs. As noted earlier, at first she believed that the outdoors was associated only with the teaching of biology. This belief stemmed from her formal training as a chemist resulting in the misconception that biology teachers had 'special' training and knowledge of teaching in alternative contexts. By teaching outside, reflecting on practice outside and collaborating with her biology colleague (Charlie), Claire's beliefs altered and her teacher efficacy increased.

The second belief influencing Claire's teacher efficacy was that once outside, students would misbehave and colleagues' lessons would be disturbed. Within Claire's classroom, students were observed to behave well. Her doubt was in her ability to transfer (or develop new) practices outside – causing 'depressed efficacy'. As this belief became less pronounced, and Claire believed she was able to teach outside whilst remaining in control, its negative influence on her teacher efficacy decreased. However, it was never fully extinguished. Claire's concern about colleagues being disturbed remained. The physical context within which Claire taught was partially responsible; the outdoor space was limited and overlooked by classrooms. Noteworthy is Megan's concurrence with Claire, as both were considered *successful* teachers, in that the ability to teach outside was closely related to the physical space available:

> We are quite fortunate, behaviour is less of an issue with the girls, and therefore we are fairly comfortable with taking them outside, because they are good. And they are easy to take because it is in a contained area. It's a very different situation if you haven't got this sort of area, I imagine, and the calibre of kid. They are super. So from that point of view, it definitely makes a difference.
> (Megan, Interview, April 2009)

However, returning to Claire, her concern is not only about the physical context but perhaps also stemmed from the school's ethos – one suggested as judgemental – as she was so concerned with disturbing others (see Section 6.2.3.4). Furthermore, her colleague, Charlie, voiced similar concerns about disturbing classes and being judged by others to 'lose control' (see Section 6.4.3.4). A school environment – informing the collective efficacy – might undermine both Claire's and Charlie's teacher efficacy.

7.3.2 Moderate teacher efficacy: range of practice implementations

As Table 6-2 summarised, in Year 1, Charlie and Tom's teacher efficacy were judged as moderate. However their implementation of practice differed: Charlie's was judged successful whereas Tom's was moderately-successful. In Year 2, both teachers' teacher efficacy remained unchanged however their RPTE altered: Charlie's was judged as moderate-high while Tom's was moderate-low. In Year 2, Charlie's practice was judged to increase becoming very successful. Tom did not trial any activities; hence his practice implementation was considered to remain moderately successful. Hence in terms of the relationship between teacher efficacy and practice, two different outcomes resulted although both teachers had similar teacher efficacy starting points.

There are two, possibly connected, explanations for the different outcomes. The first relates to the teachers' estimation of task demand, frequently drawn from prior experiences. Future judgements are informed by the frequency, range and resulting outcomes of teachers' prior experiences, both outside and in teaching aspects of the programme's pedagogical framework (Guskey, 1986, 1989). Table 5-1 shows that Charlie and Tom's experience of outdoor work differed: Charlie had some experience whereas Tom had none. In terms of CASE, an element underpinning the programme's pedagogical framework, Charlie had substantial experience whilst Tom had very little (see Section 6.4.1 and 6.7.1). Hence, in Year 1, Charlie's teacher efficacy might have been more realistic than Tom's due to having substantially more experience. Tom's teacher efficacy might be the result of an underestimation of the task. Bandura (1997:64) postulates that underestimation 'produces errors in the direction of apparent over assurance' and 'insufficient allowance for likely impediments may yield over confident judgement'.

The second reason as to the different outcomes for Charlie and Tom relates to how the initial year was experienced. Wookfolk Hoy and Davis (2006) explain that outcomes from original decisions inform resultant teacher efficacy, influencing future goals set and the effort invested as well as the level of perseverance in the face of difficulties. So, whereas Charlie experienced a number of successful lessons, where significant learning occurred, Tom experienced relatively poor student behaviour resulting in limited learning occurring. One factor contributing to teacher efficacy was the frequency with which the programme activities were attempted. The initial trials of programme activities were often challenging due to the different contexts and pedagogy. However, as the trials became more numerous, challenges were overcome and successes were more frequent. So, although Charlie experienced challenges in teaching the activities, the setbacks may have been negated, eventually, by successes due in part to the high frequency of lessons trialled (n=14). Tom did not experience this transition, where successes out-weighed challenges, due to the limited number of lessons trialled (n=7) (Table 6-1). This might be one reason for his eventual discontinuation of the lessons.

7.3.3 Conflicting teacher efficacy and RPTE: *less successful* implementation

Michael presents a complex case in that his high teacher efficacy resulted in unsuccessful rather than successful practice. Furthermore, there is a conflict between reported teacher efficacy and the researcher's perception of his teacher efficacy. Turning first to the former issue of teacher efficacy and pedagogical practice: Michael, over the duration of the programme, reported high teacher efficacy. For example, he frequently rated himself as 'very confident' in terms of teaching the activities following the programme sessions and reported a very high STEBI score (see Appendix 16 and Appendix 17). However, his practice declined from moderately successful to unsuccessful, a status exemplified below in an extract from an observed lesson, where traditional teaching methods dominated, and limited attempts were evident in terms of including pedagogical practices discussed in the programme sessions:

> The setting the scene 'pillar' consisted mainly of the theory on light, which usually is explored over several lessons in a 'normal' lesson. Michael, using a PowerPoint presentation for 20 minutes, described the theory. The girls were then expected to apply this theory to any example that arose over the following 40 minutes outside.
> (Michael, Observation, July 2008)

Michael presented a picture of high teacher efficacy but did not integrate the programme's ideas into his practice. Several potential explanations for this observation emerge. First, Michael might have been similar to a teacher in Southerland *et al.*'s (2011b) vignette, 'Beth', who judged herself to have high self-efficacy but who was not observed trialling new strategies following a professional development programme. The authors proposed that 'pedagogical contentment' caused a lack of engagement and change in practice. That is to say, the omission of professional doubt, possibly caused by a lack of reflection and evaluation, was considered to leave 'Beth' less 'conducive to openness, receptivity, or strong engagement with professional development messages' (Southerland *et al.,* 2011b: 308).

A second explanation for Michael's lack of pedagogical change similarly acknowledges that simply possessing high teacher efficacy is not enough. As was discussed earlier, in the case of Tom, Michael might not have fully appreciated the performance criteria that he was using to judge his teacher efficacy, a deficiency due perhaps in part to past experiences and to his approach to learning judged as 'surface' rather than 'deep' (Marton, 1988). For example, when Michael responds that he taught CASE lessons, his approach might be described as 'surface' – that is teaching occasional lessons from the CASE folder (see Section 6.3.1). However, probed further he was unable to explain cognitive conflict, and indicated no interest in building up a deeper knowledge of the CASE course. This lack of understanding might explain an over-estimation of his ability. As Bandura (1997:65) argues, 'The accuracy of efficacy beliefs will depend partly on knowledge of the subjective criteria on which one's performances will be judged'.

A third explanation draws on the observation that there was an inconsistency between Michael's reported teacher efficacy and the RPTE, highlighting the importance of the inclusion of more than one teacher efficacy measure. Michael reported his teacher efficacy as high whereas using the RPTE framework it was judged as moderate-low (Table 6-2). This contradiction might be due to Michael's habit of saying what he felt was expected, or what might be described as 'talking the talk but not walking the walk'. So, if Michael was to feel less confident in his ability to implement ideas from the programme than his teacher efficacy value reflected, his somewhat apathetic attitude was understandable and predictable (Bandura, 1977).

Determining which explanation outlined above might be more probable might be futile. In line with Southerland *et al.*'s (2011b) findings, all, to some extent, might be at play. That is to say, a lack of pedagogical discontentment, due to limited reflection and understanding of the programme's pedagogy, coupled with conflicting teacher efficacy and RPTE, would result in unsuccessful pedagogical practice.

7.3.4 Low teacher efficacy: *less successful* implementation

Cara presented an affective disposition of moderate-low teacher efficacy during Year 1 increasing to moderate during Year 2. Although her RPTE was thought to be the same as her teacher efficacy judgement for Year 1, it was not judged to alter in Year 2: remaining at moderate-low. Cara's implementation of the pedagogical practice, considered moderately successful during Year 1, was predicted to have remained constant during Year 2 (this *status quo* was based on the low number of lessons trialled during the second year). The quotation below exemplifies Cara's *less successful* implementation of the programme. That is, no attempt was observed to elicit students ideas either from small groups or from whole class questioning whilst outside.

> I: What do you think your role was outside?
> Cara: Mine? Keeping them concentrating, keeping them on task… like a policewoman.
> *Cara circulated amongst groups but did not really talk to students as a collective when outside; we were out there for a very limited time*
> (Cara, Interview and observation, June 2008)

Two explanations might be given for the mismatch between Cara's teacher efficacy (moderate) and the RPTE (moderate-low) in Year 2. Cara's increased teacher efficacy might have been the result of her absence from the final three programme sessions and her limited attempts to trial the activities during Year 2. Perhaps some ambiguity concerning the programme's criteria had arisen. As Bandura postulated, 'Underestimating task demands produces errors in the direction of apparent over assurance' (1997:64). Or due to the duality of my role, that is researcher and programme tutor, and having known Cara from a previous outdoor related project, her claims of confidence might be related to her wanting to relay an inflated, rather than an honest impression.

Cara initially dedicated considerable time to planning the outdoor activities, however, the flurry of effort was not maintained. Pajares (1996) notes that efficacy beliefs not only determine the effort expended but the length to which a person 'perseveres when confronted with obstacles' (p.544). Bandura (1993:131) concurs: 'When faced with obstacles and failures, people who harbour self-doubt about their capabilities slacken their efforts or give up quickly'.

Like Charlie, Cara's suppressed teacher efficacy stemmed from doubts in her ability to manage student behaviour. Also, like Charlie, her management strategies were considered effective highlighting the frequent discord between future judgement and actual outcome. Borrowing from Festinger (1957), Wheatley (2002) postulated that when a teacher already has cognitive dissonance about a particular aspect of teaching, in this case managing students within a familiar context (the classroom), it is understandable if they entirely avoid teaching methods, within an unfamiliar context, if it were thought that increased dissonance would result. Furthermore Mulholland and Wallace (2001) found that teachers with lower teacher efficacy for classroom management were more likely to avoid hands-on science activities – with whole class inquiry activities being replaced by teacher demonstrations.

Wheatley (2002) explained that teachers were able to reduce dissonance by mentally devaluing the importance of the content or the effectiveness of the methods in question, which prevented any subsequent sense of guilt attached to giving up. As Cara's teaching beliefs were aligned with those of the pedagogical framework underpinning the programme, I propose that a process of devaluing the methods occurred. An example of this phenomenon is seen when she qualifies why she decreased her efforts in using the pedagogy:

> Not doing it because you have very difficult behaviour groups to deal with, and sometimes it might not seem like it's worth the effort, unfortunately. And planning, you can plan something down to the minutest (sic.) detail and then it rains, or you are trying to show some forces and everything blows away, and trying to find bits for the Egg Box and everything's disappeared, or has been collected, and everything's gone.
> (Cara, Interview, July 2009)

This state of mind appeared to enable her to justify her lack of implementation of the programme.

Charlie and Cara commenced the programme with similar levels of teacher efficacy (see Table 6-2) however different outcomes resulted for each teacher. Charlie went on to overcome 'cognitive dissonance' and did not reject hands-on activities, as Mulholland and Wallace (2001) predicted. Charlie's teacher efficacy and RPTE increased, as did the quality of his practice. Two contextual differences are apparent between the two participants: support of colleagues and school ethos. Both factors contribute to a school's collective efficacy (Bandura, 1997) which influences an individual's self-efficacy. Although the focus of this thesis was not collective efficacy, hence data specific for this purpose was not collected, the evidence from the interview data in which teachers discuss their colleagues', department's and whole school support of the professional development programme allows some speculation as to the nature of Charlie and Cara's perceived school's collective efficacy.

Charlie's perceived school's collective efficacy appeared as moderate. That is, on the one hand, he worked closely with a keen and experienced colleague, within a department that fostered CASE teaching. On that other, he questioned how senior staff perceived his teaching, and more specifically his ability to manage students outside (see Section 6.4.3.4). The following extract exemplifies his positive relationship with his colleague:

> I: Were there benefits to working with a colleague?
>
> Charlie: It would be very different if it weren't Claire I think, because she is very good at all the kind of leadership things, so she has been very good implementing the lessons within the department. And she's had the sort of clout to do that, and she's led the GCSEs so she can say we can do these. She's got quite a big influence in the Key Stage three stuff, she's got a management position, so she can put her opinion across. I think I would have found it more difficult to do that. And we share resources, we share ideas, we talk about all the lessons that we've done, and what worked, and what was more difficult. So we can feedback that way with each other. I would have found it a lot harder if I didn't have a colleague to work with

> on it. It would have been completely different. I wouldn't have tried so many lessons, I wouldn't have taught so many of the lessons. (Charlie, Interview, June 2009)

I would suggest that Cara's perception of the school's collective efficacy was low. This rating was in part due to her reaction to the departure of her supportive colleague (also a member of the senior staff) during the first year of the programme. It was also caused by the reduced support from the senior staff in her participation in the programme, whereby teachers were no longer encouraged to attend external professional development sessions:

> I: Would you say you felt supported by your department and your school with the project?
>
> Cara: Definitely by the department, they are very encouraging, especially when Jane was head of department, because she really liked the sound of it and wanted to use it in some way, shape or form. However, as much as the school would probably want the science department to use this sort of way of teaching I don't feel I was supported in the fact that I couldn't go on several occasions, so in that respect, no.
> (Cara, Interview, July 2009)

The change in policy might have been a response to the 'satisfactory' Ofsted inspection that had commented on a potential relationship between staff absence and poor student behaviour (Ofsted, 2008).

Hence, Charlie's context might be considered to have moderate collective efficacy offering conditions relatively supportive to teachers' trialling new strategies whereas Cara's context in presenting low collective efficacy may have acted only to confirm her already moderate-low teacher efficacy – perhaps undermining it further. Hence, where risk-taking was not encouraged, moderately successful programme implementation resulted.

7.3.5 Summary

This section explored the interplay between teacher efficacy and pedagogical practice. Three different relationships between teacher efficacy and implementation have emerged and findings related to teacher efficacy measurement and contextual influences have arisen. Turning initially to findings concerned with relationships, the first finding suggests that when teachers have high teacher efficacy programme implementation was *successful* (Megan and Claire). Although unsurprising, what was noteworthy was that neither teacher's efficacy was judged as being very high. Both teachers held specific doubts related to pedagogy but maintained a generally high teacher efficacy. I suggest that these doubts caused pedagogical discontentment (Southerland *et al.,* 2011a) – a disposition initiating positive action.

The second teacher efficacy/practice finding was that both teacher efficacy and practice can change. That is to say, over the duration of the programme teacher efficacy and pedagogical practice were observed as dynamic. Noteworthy was that change was bidirectional: Claire's teacher efficacy and practice increased whilst Tom's teacher efficacy decreased – his practice was assumed to be unchanged. Furthermore, it emerged that likelihood to change was more evident for teachers who had moderate teacher efficacy in Year 1 – Charlie and Tom. A factor identified as leading to lowered teacher efficacy occurred when an under-estimation of task demand was evident, caused by a lack of understanding of the pedagogical practice, resulting in an over-optimistic self-judgement. When learning outcomes were more challenging to achieve than initially anticipated, teachers' efficacy decreased, causing them to give up (for example, Tom). Conversely teachers who judged their teacher efficacy as moderate but had an understanding of the criteria were more likely to persist. Perseverance and repetition of outdoor practice resulted in increasingly more positive teaching experiences. Hence teacher efficacy, alongside pedagogical practice, increased (for example, Charlie).

The third finding associated with teacher efficacy and practice concerns teachers with low teacher efficacy from the outset (for example, Cara). Cara, with this disposition, struggled to change – she was undermined by her negative judgement concerning her ability to implement practices successfully. Hence, due to low teacher efficacy, the need to reduce cognitive dissonance meant that she was inclined to give up attempting to implement the programme pedagogy.

Capturing 'authentic' insights of teacher efficacy was challenging. Contradictions were found between what teachers said and what they did (for example, Michael's reported teacher efficacy portrayed him as a teacher of successful implementation however in practice this was not substantiated); hence the importance of the two measures – teacher efficacy and RPTE.

Finally, teaching contexts as well as teachers' beliefs appeared to influence teacher efficacy and resulting behaviours. The influence from contexts on teacher efficacy was identified as collective efficacy, thought to be informed by colleague participation in the professional development programme and whole school ethos. When school contexts were considered to have moderate collective efficacy, the conditions were found to be more supportive of teachers to trial new strategies (for example, Charlie). In contrast, where collective efficacy was low, risk-taking was not encouraged (for example, Cara). Section 7.4 considers the interplay between beliefs, teacher efficacy and practice.

7.4 Teachers' beliefs, teacher efficacy and practice interplay

Following on from the cross-case analyses of teachers' beliefs (Section 7.2) and teacher efficacy (Section 7.3), this section explores three instances where the two components appear to interact. First, beliefs concerning 'how children learn', identified as central to teachers' interpretation of the programme and resulting practice, are examined in relation to the participants' level of teacher efficacy. Second, as a significant emphasis of the professional development programme was on teaching outside, I examine how teacher efficacy and beliefs concerned with outside teaching appeared to combine to influence teachers' practice. Finally, the relationship between beliefs and teacher efficacy related to managing students' behaviour is discussed.

7.4.1 Beliefs about how children learn: teacher efficacy and practice interplay

Teachers' beliefs about how children learn appeared to have a substantial influence on three other characteristics: other related beliefs about teaching, resulting pedagogical practice and teacher efficacy specific to implementation of the programme's pedagogy. For the latter point, three different outcomes were observed. First, when beliefs were held in concordance with the programme's pedagogical framework, a state of high teacher efficacy was already established and positive outcomes from teaching were observed, teacher efficacy increased. An example is Claire's case study, in which her moderate-high teacher efficacy and successful practice in Year 1 increased to high teacher efficacy and very successful practice in Year 2. Using Bandura's sources of self-efficacy theory to explain Claire's change in teacher efficacy, it is probable that a mastery experience was achieved (Bandura, 1997). That is, on setting and achieving the goal to teach within the pedagogical framework outside the classroom, Claire's success contributed to her development of a 'robust belief in one's personal efficacy' (Bandura, 1995:3). Claire's relatively high teacher efficacy from the outset of the programme also contributed to her success. Bandura identified this attribute as the fourth source of self-efficacy – an individual's physiological and emotional state (Bandura, 1997). Sources of teacher efficacy are returned to in Chapter 8.

The second outcome observed with regard to teacher efficacy and practice was when beliefs were recognised to be in concordance with the pedagogical framework, but only moderate-low teacher efficacy was held from the outset of the programme and *less successful* outcomes were observed. An example is Cara's case study, where her moderate-low teacher efficacy resulted in moderately successful implementation leading to a discontinuation of the activities. So, even though her beliefs were in concordance with the pedagogical practice, the low state of her teacher efficacy and the *less successful* outcomes resulted in her being less able to 'muster what ever it takes to succeed' (Bandura, 1995:3) as failures reinforced her already suppressed teacher efficacy.

The final outcome observed was for teachers who were judged to have moderate-low RPTE, whilst reporting to have moderate or high teacher efficacy and whose beliefs about learning were contrary to those underpinning the programme's framework. Where this was the case, for both Michael and Tom, *less successful* practice resulted which led to the eventual decline in the number of activities trialled. As discussed in Section 7.3.3, high teacher efficacy might have been caused by a lack of understanding of the required pedagogy necessary to teach the activities (Bandura, 1997). This lack of understanding was possibly caused by the teachers' beliefs about learning and teaching that conflicted with those underpinning the programme. Hence, on trialling activities and using teaching strategies more in-line with behaviourist/traditional beliefs, the outcomes discussed at the sessions and on the activity outlines were unobtainable. Lower RPTE resulted, however trialling of the new pedagogy stopped thus preventing further negative experiences.

7.4.2 Beliefs about teaching outside: teacher efficacy and practice interplay

Leaving aside teachers' beliefs about how children learn – two further beliefs identified as influencing teacher efficacy and practice outside were: conceptualisation of the outside and subject discipline. Table 7-1 summarised beliefs about teaching and learning outside for teachers judged as having *more* or *less successful* practice (broadly aligned with social constructivist and behaviourist/traditional beliefs). A distinct difference was evident between these two groups of teachers' beliefs. *More successful* programme implementers believed the outdoors offered science opportunities for students to apply their knowledge and to develop new skills whilst becoming more aware of their environment. The teachers believed that students would have to be taught new skills and that preparation was essential. It is in terms of this final point, preparation, where teacher efficacy interrelates. *More successful* teachers were aware that to achieve their goals, substantial preparation was required. However due to their high teacher efficacy their plans were flexible which in turn fed back into their teacher efficacy.

In contrast, *less successful* programme implementers saw the outside as just another medium, essentially offering novelty, and a place where students could demonstrate what they had learnt inside – rather than developing new knowledge. However, although the need for preparation was acknowledged, it was conceptualised as a barrier rather than an opportunity. As previously discussed, such beliefs might have stemmed from the indifference felt towards the teaching context.

Comparing *less successful* implementers' beliefs and teacher efficacy: Michael, for example, to maintain his high-moderate teacher efficacy, blamed behavioural difficulties on students rather than his lack of preparation. Similarly Tom, who maintained moderate teacher efficacy, blamed the lack of resources outside, rather than his own inability to prepare. Hence I postulate that teachers' beliefs not only influenced practice but also maintained levels of teacher efficacy.

Turning to subject disciplines, the discussion in Section 7.2.2 focused on the relationship between science disciplines and teaching practice outside. A mixed picture emerged, biology specialists, for example, were not found to have better pedagogical practice or higher teacher efficacy than teachers of physics or chemistry. However, noteworthy was the influence the misconception could have on teacher efficacy. For example, Claire (chemist), in Year 1, did associate biology teachers with the outdoors and believed they had special training to teach in the context. This belief undermined her teacher efficacy. During Year 2, her beliefs changed and she saw teaching all science disciplines outside as possible and possibly as a result, her teacher efficacy increased.

Subject disciplines did have an influence on activity choice for several teachers. For example, although Michael (physics) and Charlie (biology) did trial activities from several subject disciplines, the activities they taught most often were those in closest association to their subject specialism. This pattern relates to teacher efficacy in that depending on how good they judged their subject knowledge to be would influence the type of activity chosen to teach.

7.4.3 Teacher efficacy to manage outdoor learning: beliefs and practice interplay

Section 7.2.4 outlined how teachers' beliefs concerning managing students related to several factors: how they believed children learned; how they believed they should be taught, and their judgement of their ability to enact these pedagogical practices. The latter point, concerning teacher efficacy in managing behaviour, influenced all the participants independent of their beliefs about how children learn and, for the majority of teachers (apart from Megan) seemed to be partially responsible for lower teacher efficacy which in turn influenced pedagogical practice. An example, as was described in Section 7.2.4, was Claire's belief that students will become distracted outdoors and that poor behaviour would follow. She was unsure if she would be able to manage potential misbehaviour and the result was that she altered her teaching practices to those more aligned with traditional approaches. However, when her judgement about her ability to manage students was not justified, her teacher efficacy increased and social constructivist teaching approaches were transferred from the classroom. A second example was Cara, described in Section 7.3.4, who had moderate-low teacher efficacy which stemmed from her judgement of her ability to manage the students – both inside and outside. In the classroom, her practice was noted as successful, however her teacher efficacy influenced her practice outside so that she framed her role as 'policewoman' rather than teacher. Ultimately her low teacher efficacy was partially responsible in leading her to give up teaching the activities outside. This low teacher efficacy was in contradiction to the positive experiences achieved outside.

Teacher efficacy is a judgement of one's ability 'to organise and execute the courses of action required to successfully accomplish a specific teaching task in a particular context' (Tshannen-Moran *et al.,* 1998: 233) and there, I suggest, lies the problem. That is, where teachers *might* be able to prepare for most eventualities, and as was discussed in Section 7.4.2 teachers considered as *more successful* at programme implementation do, predicting and planning for potential behavioural problems when outside is very challenging. Not only is the space ever changing, including the 'science' examples, the range of distractions and the weather, students' responses to the space are ever changing, too.

7.5 Chapter summary

Using a cross case analysis of six participant teachers involved in a professional development programme to enhance science teaching outside, this chapter has explored the relationships between teachers' beliefs and practice, teacher efficacy and practice before reflecting on the interplay between all three: beliefs, teacher efficacy and pedagogical practice.

Two broad categories of practice, judged on the degree and quality of programme implementation, were identified – *more successful and less successful.* Section 7.4 presents three key findings. First, teachers' beliefs concerning how children learn influenced the majority of other teaching related beliefs studied and, in turn, their pedagogical decisions. This finding was true both inside and outside the classroom. Second, subject discipline had little influence on teachers' belief about teaching science outside in the majority of cases. However teachers' subject specialism did in several cases, influence activity choice. Third, teacher efficacy relating to managing student behaviour influenced the majority of teachers' pedagogical choices. Even when teacher efficacy was found to increase, an underlying concern regarding student behaviour outside remained.

This chapter has introduced a new measure, researchers' perception of teacher efficacy (RPTE). Rather than explicit statements related to teacher efficacy – that is the lesson activity confidence scales, STEBI instrument and direct statements of confidence – the RPTE tool, informed by teacher efficacy literature describing teachers' practice and related behaviours, offered a complimentary tool to explore further teacher efficacy claims.

Over the two-year professional development programme teachers' pedagogical practice and teacher efficacy changed. Chapter 8 considers which particular planned programme strategies were identified as most influential in developing the case study teachers' practice. Bandura's theory of sources of self-efficacy is used to consider why some strategies might be more beneficial than others.

Chapter 8 Influential Professional Development Strategies

8.1 Introduction

This chapter addresses the research question: What professional development strategies are significant in influencing teachers' practice? The chapter's findings, alongside those of Chapter 7, will inform the discussion (Chapter 9) concerning the contribution that teachers' beliefs and teacher efficacy have on the interpretation of professional development programmes. To this end, where appropriate, Bandura's (1997) theory of teacher efficacy sources provides the analytical framework (as discussed in Chapter 3).

In Chapter 2, professional development was conceptualised as an *action* aimed at changing a teacher's practice for the advancement of *their learning*. The premise underlying the purpose of professional development is that teacher advancement will, directly or indirectly, influence student learning. The extent to which an *action* changes pedagogical practice is difficult to measure. Teachers might report 'enjoying' or 'find rewarding' particular aspects of a professional development programme but such opinions do not necessarily translate into new learning or pedagogical change. Hence, several data sources are used to substantiate findings, in particular observations of teachers' practice (as discussed in Chapter 5).

The professional development programme undertaken by the case study teachers was considered transitional/transformative rather than transmissive (Kennedy, 2005). That is, rather than the one-shot deficit transmission model approach, transformative professional development was conceptualised as 'internalisation of concepts, reflection, construction and new knowledge' requiring an extended period of time (Fraser *et al.,* 2007:159). To this end, aspects of the programme considered to induce change were not limited to those incorporated into the six programme sessions but also included factors in school (for example, working with a colleague) and beyond (for example, presentations at conferences). Appendix 18 lists the professional development strategies and Appendix 25 summaries the programme strategies identified as influential on practice. Finally, with reference to the literature concerning sources of teacher efficacy (Section 3.4.3),

Appendix 26 presents the professional development strategies identified as sources of teacher efficacy. Hence, recognising that professional development is a cognitive process (Piaget, 1952; Vygotsky, 1978) whilst being situated across multiple contexts (Sfard, 1998), this chapter will initially discuss strategies of the professional development sessions identified as influential on teachers' practice, before turning to examine the influence of professional development strategies in school and other social settings.

8.2 Professional development: the sessions

Section 2.2.2 outlined Adey's (2004) critique of the DfEE (2001) code of practice for professional development providers in England. According to Adey (2004: 184), the code omitted any guidance to providers on 'the nature of the innovation, or development' and displayed an exaggerated concern with management, including planning, course venue arrangements and programme evaluation. The code's focus on management is understandable; recommendations will largely be relevant across multiple contrasting professional development programmes. In order to begin to address the nature of innovation more fully, this thesis separates the strategies into two categories: strategies transferable across other professional development programmes and strategies specific to the 'Thinking Beyond the Classroom' programme.

Section 8.2.1 discusses the first category: strategies emerging from the present study that may be transferable across other teacher professional development programmes. These strategies relate to: how the innovation/activity was introduced; whether lesson guidance and resources were distributed; and the extent of involvement of participating teachers in programme sessions. The second category consists of strategies specific to the programme. That is strategies considered enmeshed with the four principles of the programme discussed in Chapter 4, and the emerging theme 'managing students outside'. Establishing whether the nature of the innovation – that is the pedagogical principle – or the method used to introduce it was the main factor influencing practice is challenging, therefore, Section 8.2.2 discusses both the principle and the associated professional development method.

8.2.1 Strategies transferable across other programme sessions

Three themes emerged concerning general strategies influencing teachers' practice. These were: how activities were introduced; the distribution of lesson plans and resources; and, teachers' involvement in professional development sessions. Each theme is discussed below.

8.2.1.1 Introduction of activities

Professional development programmes enhance teacher efficacy and in turn teachers' willingness to implement new pedagogical practices (Murphy *et al.,* 2007). Where activities were introduced through what Palmer (2006) coined simulated modelling – teachers' role-played students while programme tutors role-played the teacher – a greater confidence to trial the activity was reported compared to activities introduced using other methods. Appendix 16 summarises these findings: Eggbox, Urban Jungle and Forces all around us, which were all introduced through modelling received high confidence ratings in session evaluations, and were frequently trialled with students. In contrast, teachers rarely commented on less participatory methods such as reading the activities or stimulated discussion through the use of props (see Appendix 25). Furthermore, teachers reported lower confidence to implement activities such as Back to the Sun and Materials, which were both introduced through non-participatory methods (see Appendix 16). The following extract reflects these findings:

> I: What suggestions do you have for improvements to the professional development days?
>
> Claire: […] I think without making the sessions any longer, it would be difficult to do them in a different way, and yet still achieve everything. I think some of the sessions – we could do with going through more of the activities. Because initially we tended to do [teach] the activities that we'd gone through on the sessions. And the others, like the Back to the Sun one, where they just gave us the lesson plans, we were quite slow doing it [teaching it] – we did the ones we'd go through ourselves first at school. So I think modelling all the activities would've been useful – because the ones we didn't model we just didn't do (initially).
> (Claire, Interview, June 2008)

How an activity is introduced to teachers during a programme may lead to increased teacher efficacy (Brand and Wilkins, 2007; Bruce and Ross, 2008). Palmer (2006) and Bautista (2011) proposed that, in a professional development context, simulated modelling is a significant teacher efficacy source, Bautista categorising it to offer vicarious experiences. The case study teachers appeared to concur that it did indeed act in this way. For example, Megan reported that through simulated modelling: '[…] you feel much more confident - oh that's what you do, oh that's easy I can do that.' Which she claimed initiated her 'to kind of start and get better and better' (Megan, Interview, April 2009).

As well as acting as a potential vicarious experience, I propose that simulated modelling also acted as a source for mastery experience. In the past, opportunities for mastery experiences were generally considered to only be available through teaching and not within professional development sessions (Bautista, 2011). However, on exploring recent re-conceptualisations of mastery sources, simulated modelling could be said to offer similar opportunities. That is, Palmer (2011) categorised mastery experiences as being: *enactive mastery*, that is perceived success in the actual teaching of science, and *cognitive mastery*, that is perceived success in understanding a pedagogical concept. Palmer (2011) proposed that cognitive mastery could be achieved through all aspects of a professional development programme, whereas enactive mastery was only available to teachers when they were teaching their students. I suggest that the simulated modelling used in this research acted as a source for cognitive mastery for all six case study teachers who were able to perceive success in understanding a pedagogical concept. Furthermore, within cognitive mastery experiences two sub-groups were identified in the data reflecting the specific aspect of the source influencing teacher efficacy. First, modelling offered an opportunity to develop empathy for how students might experience the activities as indicated by these two quotes:

> Trying out the various activities gives you real insight into how your students may approach things.
> (Claire, Session evaluation, November 2007)
>
> Actually getting a chance to try the activities yourself. Just getting the chance to put yourself into the kids' shoes, really. That was really valuable.
> (Cara, Interview, July 2008)

Second, modelling offered teachers an opportunity to become quickly familiar with the activities as is suggested by this exchange:

> I: What was useful about the professional development sessions?
>
> Michael: I think it's good because of the sort of hands-on nature of it […] that when we were given an actual practical to do, it was go out there and do it, and then you have to go through the whole process, and you can see where the sticking points might be. When you are just teaching something and you are sort of slightly above it, from that, you are so engrossed in knowing what is going on and trying to learn it

> that you can sort of miss out on the sort of small stumbling blocks that they [the students] might come across.
> (Michael, Interview, July 2009)

Hence, simulated modelling involved several potential sources of teacher efficacy possibly explaining the substantial influence it had on the teachers. Bruce and Ross (2008) echo this finding, 'teacher judgements about their abilities to influence student learning were affected by the combinations of efficacy information sources' (p.363). The researchers further suggesting that:

> The nexus of efficacy information sources reinforced one another to provide the participants with strong positive messages about their teaching which, in turn, encouraged further risk-taking and implementation of challenging strategies. (Bruce and Ross, 2008: 363)

'Reading activities only' had the reverse impact on teachers' confidence and willingness to implement them. Reasons as to why this was the case are expressed in the extracts below. These included lack of time to read through an activity and the text not transmitting a true sense of the ideas. The extracts also illustrate different responses to the method – Claire rejects trialling the activity whilst Megan trials the activity but blames the negative outcome on the original programme dissemination:

> I think Turning over a new leaf was one of the ones that we didn't have time to go through in the PD [session]. It was more – here is the lesson plan. So I don't really feel like I know what the lesson is like and whilst I am sure if I sat down properly and read the notes I could make sense of it, it's that I do not really know what it is about so I will leave that one and do the ones I do know something about.
> (Claire, Interview, March 2009)

> Where I think if you're just given something and say this is what you've got to do the research and reading up behind it making sure you know what you've got to do is actually quite hard sometimes, and you don't always have time. And the first few you do are a complete nightmare, you think well actually I'm not going to do that again it was a disaster.
> (Megan, Interview, April 2009)

8.2.1.2 Distribution of resources and activity outlines

All the case study teachers acknowledged that they were more inclined to trial an activity when there was a related resource. Resources were referred to in two respects: those distributed at the session – for example, filter eye-glasses and fold-out identification keys – and those to be acquired to teach the lesson – for example, egg boxes, balls, paper arrows and cameras. The physical presence of the resource was to serve as a reminder of the activity. The resource also provided novelty, stimulating teachers' interest to trial activities. Tom, discussing the filter eye-glasses, expressed an opinion about the novelty of the resource:

> Because I remember, particularly the Rose Tinted Glasses one, Zara [Tom's colleague] and myself were outside in the park there, and we were laughing like idiots, we were having a great time, just looking at things and seeing how everything was going. And that made us think this is good, if we like it this much the kids will like it, and it will be great fun – look at this, look at this! Because me and Zara were looking at things – what colour do you see? Ooh, what do I see? And it was actually fascinating, and it fascinated us, the same with the kids.
> (Tom, Interview, June 2009)

A related factor concerns the content of activity outlines distributed during the sessions. Those with clear written links to the National Curriculum were reported as more likely to be trialled than those without; a finding similarly reported by Penuel and Fishman (2012). Furthermore, for some case study teachers, opportunism alone served as a rationale for activity choice:

> I: What helped you choose which activity to trial?
>
> Tom: To be perfectly honest it was when I came back to school, where I was in the scheme of work, and if it could fit in with the next few weeks I would do it.
> (Tom, Interview, June 2009)

However, for other teachers, opportunism, although articulated, was one among several factors of influence. In the example below, the activities as 'fun'- or novel as discussed earlier – was an additional factor:

> I think the Rose-tinted glasses because it was fun and it had fun aspects to it and also because we were doing a whole topic on radiation last year with Year 9 it fitted really well. We probably would have done it anyway but it was a sort of extra reason to do it as it fitted in with what we were about to teach them.
> (Claire, Interview, March 2009)

8.2.1.3 Teachers' involvement in professional development sessions

The third emerging theme, relating to general strategies in programme sessions initiating teachers' implementation, concerned teacher involvement. Guskey and Yoon (2009:496), referring to involvement as 'active-learning experiences', similarly acknowledged the importance of teacher involvement to effective professional development workshops. *Involvement*, in this study, related to teachers being involved in their own professional development, the involvement of colleagues and being involved in activity development.

Involvement resulted from group discussions during the sessions – all case study teachers saw these opportunities as beneficial. Frequently the responses to the session evaluation question: 'Which part of the day did you find most rewarding? Why?' mentioned the group discussion, for example:

> Group feedback on activities
> Discussion about new activities
> (Cara, Session evaluation, March 2008)
>
> Sharing good practice
> (Charlie, Session evaluation, March 2008)

In a later interview, Charlie expands on the comment above:

> The discussion and the session that you run which are very open-ended and teachers share ideas and share good practice. And, hmmm… feedback what's gone well, what hasn't gone well and lead it on from there […]
> (Charlie, Interview, March 2009)

Involvement through group discussion brought a range of benefits. Teachers mentioned that it presented guidance on activity implementation and solutions to problems: 'Talking to people who have done activities I haven't tried yet to give some guidance' (Tom, Session evaluations, March 2008). In addition it acted as a tool for reflection – a time to digest what had been presented or previously undertaken in school:

> […] you've discussed the problem areas, not all of them, but a lot of the key things, so that when you go back in school you feel confident that you can go ahead and do something. So not just that it's this new idea. Because I think quite often you can come back from InSET where you are talked at, and you can come back and go – that's a great idea, oh it will never work, I couldn't do that.
>
> […]
>
> I think it gives you a chance to reflect on what you are doing anyway, because when you are talking about the ideas, quite often things are given a particular name, and it's not until you are talking about it that you go – oh actually I do something similar to that already.
> (Claire, Interview, May 2009)

As highlighted in the extract above, discussion acted to increase confidence, resulting in the trialling of new approaches in schools. Barnett and Hodson (2001) have commented, for example, that Bell and Gilbert (1996) provided convincing evidence that this important social dimension, that is collegiality, encourages and constrains individual development. Explained from a social psychological viewpoint, 'discussion' has been identified to offer two sources of teacher efficacy. The first is an emotional/psychological source. As Richardson (1995) explained:

> Having time to talk to one another is one of the most effective ways of defusing stress. It allows people to share self-doubt, express anxiety about their competence, and exchange ideas they are really proud of. (p.66)

Group discussion has also been identified as offering verbal persuasion (Bandura, 1997; Khourey-Bowers and Simonis, 2004). As a source of teacher efficacy, verbal persuasion has an optimal effect when the informant believes the source is credible and has expertise (Bandura, 1997). In this study, programme participants evolved, becoming credible sources to one another, as they implemented the activities with similar age students, curriculum constraints and, for some, in similar contexts. Furthermore credibility of other's opinions increased over the sequence of sessions as familiarity grew:

> I think it's working with the same people as well, and sharing practice, which quite often at INSETs it's people talking at you, and not necessarily sharing your ideas and your thoughts about things, so I think that was a different approach.
> (Cara, Interview, June 2009)

Programme tutors were also considered credible sources for verbal persuasion: 'It was good because you knew that they knew what they were talking about' (Claire, Interview, June 2008).

The case study teachers who had previously worked with the university tutors noted this opinion, that programme tutors acted as credible sources. Guskey and Yoon (2009) similarly acknowledged the important role the 'expert' played in effective professional development. Furthermore, the view that tutors offered credibility was rooted in their presentation of the theoretical underpinning of the programme's activities (discussed in Chapter 4; see Section 8.2.2 for a more detailed discussion of specific aspects of the theory-practice). This finding is consistent with Fraser *et al.* (2007) who conjecture that for transformative professional learning to take place, strong links between theory and practice were necessary.

A final aspect concerning teachers' involvement in the professional development relates to co-construction of lesson activities. This sentiment was expressed below:

> I: Is the professional development different from other programmes you've been involved in?
>
> Charlie: I enjoy the sessions we've had [...], the opportunity to be involved in the development of something – and it does feel like we are involved in the development of it - that our ideas are useful to construct a programme (of activities).
> (Charlie, Interview, March 2009)

Involving teachers in the development of the activities served to acknowledge their expertise. It also offered teachers an opportunity to think critically about their practice and how it related to theory. The influence that co-construction has on practice corresponds with Henson's (2002) findings that for professional development programmes to influence teacher efficacy they need to 'compel teachers to think critically about their classroom and behave actively in instructional improvement' (p.143). Thus, I suggest that evaluating and developing activities offered teachers the opportunity to think critically, potentially resulting in cognitive mastery experiences (Palmer, 2011).

8.2.2 Strategies specific to 'Thinking Beyond the Classroom' programme sessions

Section 8.2.1 dealt exclusively with factors considered transferable across professional development programme sessions. Extending Adey's (2004) argument that professional development provision is influenced by the nature of the innovation, this section discusses factors of the study's professional development specific to the 'Thinking Beyond the Classroom' programme. As previously outlined, the programme was underpinned by a pedagogical framework consisting of four principles, discussed in Chapter 4, plus an additional emerging theme, 'managing students outside'. Establishing whether a principle – the nature of the innovation – or the method used to introduce it was the main factor to influence practice was challenging. Therefore, both the principle and the associated professional development strategy are discussed below.

8.2.2.1 Principle: collaborative group work

Strategies associated with developing students' collaborative group work skills were observed across the majority of case study teachers' practice. Of the four principles, this one was considered to have a large influence on practice. The following extract exemplifies typical practice associated with developing collaborative group work:

> Charlie: In your groups, discuss how the group work went the last time – what did or did not work well? What you needed to do to work well as a team?
>
> Gave them two minutes
> Had each group write down three rules
>
> C: What new rules might we need for the group work today?
> (Charlie, Observation, July 2008)

From the case study teachers, two reasons emerged as to why group work was so readily taken up following the programme sessions. First, the tutor presented the theory on why group work mattered. This strategy acted as a source of verbal persuasion (Bandura, 1997). In the following extract, Charlie acknowledges this method before going on to explain the importance:

> Charlie comments on how he decided to group a Year 9 group
> I: So you are saying that you picked up the idea from the tutor, from the professional development and you hadn't thought about it before in that sense?
>
> Charlie: No.
>
> I: No, okay.
>
> C: Actually maybe I had thought about it before, but I hadn't really felt that it mattered too much in the classroom situation where you were doing a short bit of group work where you would just sit within the groups at the tables that you had normally sat in. However that was arranged and you would do your group work activity. And then we would get on with the rest of the lesson. But for this it seems so important because it is a big chunk of work and it is done in an outdoor setting where I have got less control of them already. So I was much more aware of the importance of having groups that work, I mean groups that were able to work well together.
> (Charlie, Interview, March 2009)

Second, developing group work enabled learning, however, it also acted as a tool for behaviour management (discussed further in Section 8.2.2.4). This sentiment is evident above when Charlie notes he has 'got less control' outdoors and the same feeling was evident across the majority of case study teachers (discussed in Section 7.2.4).

8.2.2.2 Principle: observing the local

Observing the local through scientific observation was originally outlined in the activity sheets only. However, in response to observations that students struggled to 'observe' outside, several tutor-led simulated modelling activities were included in the sessions. Evident in session evaluation responses was that this aspect of the framework was well received:

> Reflect on one idea that you have been struck by today. How can you implement this in your classroom?
>
> Observing things from a different point of view
> Good starter activities
> (Claire, Session evaluation, May 2009)
>
> Small, short sessions to cover key skills in observation, description, communication.
> (Charlie, Session evaluation, May 2009)

Something that was also captured in the comments – 'starter activities' and 'short session' – was that the professional development had communicated observation as an additional skill, rather than a key aspect of the pedagogical framework. This point was further substantiated when observed lessons neglected 'teaching to observe' and, in contrast to group work, was infrequently referred to in interviews. Two possible factors emerged as to why *observing the local* was less readily incorporated into lessons. First, as noted earlier, it was not initially prioritised in the professional development sessions – instead it was implicit within the activity outlines and the act of working outside. Second, unlike group work, theory concerning students' skills of scientific observation was not presented. The activities were modelled, encouraging cognitive mastery (Palmer, 2011), but this single source of teacher efficacy was not enough to have a significant influence on practice.

8.2.2.3 Principles: learning through questioning and provoking cognitive conflict

Questioning is an aspect of Assessment for Learning (AfL) (discussed in Chapter 4). The majority of case study teachers were observed to implement aspects of 'questioning' in their lessons. Such approaches included open-ended, thought-provoking questions which students might discuss in pairs over an extended period. Over the past decade, AfL was actively encouraged by central government through the medium of one-day professional development sessions and guidance materials (The National Strategies, 2005). As a result, the call to develop questioning skills was familiar to participating teachers. For example, when Michael was asked about the aspect of the programme he would share with colleagues he responded:

> I suppose the questioning. Lots of these things, most staff have already been over, it's not like … people have talked for many, many years, but as I've said before it's always good to renew these things in your mind, even if you do know them before.
> (Michael, Interview, July 2009)

However, the participants' willingness to develop 'questioning' due to familiarisation as a result of government priorities on teaching and learning was never directly acknowledged. This observation echoed Adey's (2004) and Nuthall's (2005) assertion that often teachers are unaware of the impact of government policy on classroom practice.

There were, however, two clear factors concerning professional development methods and questioning which were considered influential on practice: tutor expertise and practical tools. A tutor, known for her expertise in AfL, had introduced questioning – providing a credible source of verbal persuasion (discussed in Section 8.2.1.3). Following the presentation of AfL research, a *question stem tool* was introduced (Harrison and Howard, 2010). Teachers used the tool to develop questions for previously trialed activities. In a subsequent session, the tool was used to write questions for new activities. This strategy potentially provided cognitive mastery experiences (Palmer, 2011). That is, a perception of success was developed through question construction with concrete examples of lesson activities in mind. Teachers did report the tool as useful, and questions were identified in observations where the tool had been explicitly used: 'She asks them to consider similarities and differences and which was the best item to represent them' (Claire, Observation, March 2009). Other teachers, such as Cara, reported that they had adapted the tool and provided it to students as an aid to create questions.

Methods to develop the case study teachers' use of cognitive conflict – the fourth principle of the pedagogical framework – resulted in two outcomes. Experienced CASE teachers – who understood the theory – were observed implementing cognitive conflict strategies; less experienced teachers were less frequently observed to do so. This difference is apparent in the extracts below where two teachers with different CASE experiences comment on cognitive conflict within the Urban Jungle activity. The first extract was from a teacher less experienced in CASE:

> Some of them had, some of them more than others had conflict. Like the Egg Box one sort of had some conflicts in terms of what's a gas and solid, and then you can swap around between some of those. So that was good. The Urban Jungle one, today, I am not sure if there was any particular conflict in there, or maybe there was and I didn't integrate it into it. But so, I mean, where there is, I try and get them to have cognisance that there is such conflict going on and then try and get them to integrate it.
> (Michael, Interview, July 2009)

The second extract was from a teacher more experienced in CASE:

> I: Within the lessons where have you seen cognitive conflict?
>
> Charlie: With the Urban Jungle one, it's with the 'what is a habitat'? Is it this kind of barren place that you're telling me is a habitat so why is that. Is it this picture where there are animals sitting there but, you know, really a habitat? That is where the sort of confusion and thinking was coming about at the beginning of the lesson - that they were then able to resolve the rest of it. For that one it came quite early on.
> (Charlie, Interview, March 2009)

Participants more experienced in CASE practice postulated that less experienced participants would struggle to implement strategies due to the omission in the sessions of theory/research concerning cognitive conflict (Charlie, Interview, March 2009). The activity used in one of the sessions, which asked teachers to identify the challenge or conflict in the activities, acted as a source of cognitive mastery only to those who already understood the concept. For others with less experience, the activity helped little and the concept remained abstruse.

8.2.2.4 Management of student learning

Although not a principle of the pedagogical framework, management of students' learning outside the classroom emerged as an important aspect of the programme sessions influencing teachers' practice. Evident in Section 7.2.4 was the importance that teachers placed on managing students' learning outside. Strategies addressing managing student learning included techniques participating teachers presented and a tutor-led simulated modelled activity. Acting as a potential source of verbal persuasion, the participating teachers' pragmatic advice – informed from recent in-school experiences – might be considered credible. Such advice included, practical ideas relating to student management outside whilst running plenaries and moving in and out of the classroom.

Section 8.2.1.1 discussed the influence that tutor-led simulated modelling of the activities had on teachers' practice. Modelling methods to manage students outside the classroom similarly influenced teachers' practice. Claire explained that the modelling gave her the confidence to use the idea 'so you know you can do it'. The method also encouraged preparation and planning:

> [...] knowing you could do it, but knowing that you've thought it all through. We've talked about anti-bacterial hand-gel, how do you organise them outside, what do you do, do you tell them where the boundaries are?
> (Claire, Interview, May 2009)

8.2.3 Summary

Tables 8-1 and 8-2 summarise the professional development programme session strategies which appear to have influenced the case study teachers' practice. Table 8-1 presents the strategies considered transferable to other education-related professional development programmes. Table 8-2 presents strategies specific to this study's programme: 'Thinking Beyond the Classroom'.

Table 8-1 presents three emerging strategies influencing teachers' practice: introduction to the activities, distribution of resources and teachers' involvement in sessions. Reasons as to why these strategies were considered influential were identified as either related to teacher efficacy or motivation.

Table 8-1 A summary of factors identified as influential on practice used during the study's programme sessions considered transferable to other education-related professional development programmes

Professional development session: Strategy	**Influential aspect of strategy**	**Reason for influence**	
		Teacher efficacy related	**Motivation related**
Introduction to activities	Tutor-led simulated modelling	Cognitive mastery experience	Familiarisation: less planning required in school
		Vicarious experience	
Distribution of resources and activity outlines	Novel item/prop/activity		Concrete reminder Novelty/fun

	Activity includes clear National Curriculum link		Ease to situate in teaching sequence
Teachers' involvement in sessions	Discussion with other teachers	Verbal/social persuasion	
		Emotional/psychological experience	
	Co-construction of activities	Cognitive mastery experience Verbal/social persuasion	Actively engaged; promoted critical thinking

Table 8-1 presents simulated modelling as having the potential to highly influence teachers' practice as it incorporates more than one source of teacher efficacy. That is, through modelling, vicarious, as well as cognitive mastery experiences, were both available. In addition, cognitive mastery not only offered an understanding of the nature of the activities, it also created opportunities to empathise with the student experience whilst enabling insight into the practical side of teaching the activities. That said, the findings above might suggest that multiple sources of teacher efficacy will result in raised teacher efficacy. However, Klassen's (2010) warning that currently little is known about how teacher efficacy sources interact and what might result is acknowledged.

Furthermore, the data suggests that whether a strategy became a source of teacher efficacy and/or an influence on practice, was dependent on the teachers' previous experience. For example, the case study teachers experienced in CASE teaching were more receptive to session involvement than those with limited experience. That is say, experience of CASE informed teachers' beliefs. Similarly, whether a professional development strategy was considered motivational relates to teachers' beliefs. Hence Chapter 9 will discuss the interrelationship between beliefs and professional development strategies.

Table 8-2 A summary of strategies influencing case study teachers' practice specific to the 'Thinking Beyond the Classroom' programme

<table>
<tr><th rowspan="2">Principle of pedagogical framework</th><th rowspan="2">Influential aspect of method</th><th colspan="2">Reason for influence</th></tr>
<tr><th>TE related</th><th>Practical/motivational related</th></tr>
<tr><td rowspan="2">Collaborative group work</td><td rowspan="2">Tutor-led theory/practice</td><td>Verbal persuasion
Cognitive mastery experience</td><td>Practical ideas</td></tr>
<tr><td></td><td>Student Management tool</td></tr>
<tr><td rowspan="3">AfL: Questioning</td><td>Tutor-led theory presented</td><td>Verbal persuasion</td><td></td></tr>
<tr><td rowspan="2">Practical tool distributed</td><td rowspan="2">Cognitive mastery experience</td><td>Practical ideas</td></tr>
<tr><td>Government priority</td></tr>
<tr><td rowspan="3">Management of students</td><td>Teacher-led presentation</td><td>Verbal persuasion</td><td>Practical ideas</td></tr>
<tr><td rowspan="2">Tutor-led simulated modelling</td><td>Vicarious experience</td><td rowspan="2">Practical ideas</td></tr>
<tr><td>Cognitive mastery experience</td></tr>
</table>

Table 8-2 shows the two principles, collaborative group work and questioning, and the emerging theme, management of students, alongside the strategies used to introduce them during the sessions, all of which have been identified as having influenced the teachers' practice. Principles less successfully introduced were: observing the local and promoting cognitive conflict. The successfully introduced principles, listed in Table 8-2, used strategies including: teacher and/or tutor-led theory/practice; distribution of practical tools; and, tutor-led simulated modelling. These successful strategies contrast to those used to introduce the principles less evident in teachers' practice. That is, the less successfully implemented principles did not use strategies that introduced the supporting theory or research, or make the principle explicit during the session. As with the general strategies discussed above, the reasons for influence were identified as being potential source of teacher efficacy or/and motivation.

8.3 Professional development: in school

As discussed in Chapter 2, transformative professional development includes actions outside programme sessions (Kennedy, 2005) and learning that is situated across multiple social settings (Sfard, 1998). Hence learning, not only personally constructed, is situational, being dependent on the unique setting in the broader community of practice (Lave and Wenger, 1991; Cobb, 1994). The teaching context has equal value alongside the professional development sessions; the unique settings offering the intrinsic conditions for learning, together with necessary interpretive support for sense making (Lave and Wenger, 1991). This section considers the professional development strategies/factors in school that influenced the implementation of the programme pedagogy. Described as the meso-level, Chapter 2 outlined the multiple factors within school contexts influential on teachers' practice. In this section mainly the factors that were explicitly promoted by the programme tutors to be utilised in the school contexts are explored. The intention being that a narrower research focus would enable cross-case comparison. The three strategies/factors explored are: in lessons – trialling/teaching/reflecting on activities; in the science department – working with colleagues; and in the science department – disseminating programme activities and outcomes.

8.3.1 In lessons: trialling activities

Drawing from Table 6-1 and Table 6-2, Table 8-3 summarises teachers' pedagogical practice, frequency and range of activities trialled.

Table 8-3 Summary of case study teachers' implementation of programme activities

Case study teacher	**Total number of programme activities trialled over two years**	**Number of different activities trialled (max. 10)**	**Professional development pedagogical framework reflected in teaching practice**	
			Year 1	Year 2
Michael Bison	9	4	Moderately successful - Unsuccessful	Unsuccessful
Cara Brown	8	4	Moderately successful	Moderately successful *
Charlie Pence	14	6	Successful	Very successful
Tom Peterson	7	4	Moderately successful	Moderately successful *
Megan Thomas	25+	10	Very successful	Very successful
Claire Westwood	15	7	Successful	Very successful

*No observation. Due to the number of outdoor activities taught in Year 2, practice was considered to remain constant (see discussion Section 7.3.4)

Across the interviews, all case study teachers noted the fundamental importance of trialling activities for pedagogical change. Table 8-3 shows teachers who infrequently trialled lessons (<10) and trialled a narrow range of activities (<5) were less successful in implementing the practices of the framework, compared to teachers who frequently trialled lessons (>9), across a range of activities (>4). Furthermore during Year 2, teachers who infrequently trialled activities were less successful in implementing the programme framework or stopped trialling the lessons completely. The reverse was observed for teachers who frequently trialled activities, that is framework implementation improved.

The finding, that practice frequency influenced the likelihood of positive pedagogical change, concurs with Joyce and Weil (1986) and Guskey and Yoon (2009) who postulated that approximately 30 hours of practice, coaching and feedback are required for significant change in pedagogical skills. Furthermore, case study teachers who consistently trialled the activities over the programme's duration were observed to have improved practice (for example, Claire and Charlie). This pattern corresponds with Fullan and Stiegelbarer's (1991) proposal that a minimum of two years was needed for teachers to make 'real change' in their practice, and Guskey and Yoon's (2009) assertion that significant and sustained follow-up were essential after a professional development session for change in practice to occur. Trialling lessons enabled learning whereby teachers gradually came to understand how strategies worked in different contexts.

Trialling activities also offered an opportunity for enactive and cognitive mastery experiences (Bandura, 1997; Palmer, 2011). Bandura (1997) cites mastery experience as the most 'powerful' source of influence on teacher efficacy. Michael identifies this when he says: 'It's experience in the classroom – it's probably the most significant factor in terms of how you develop professionally' (Michael, Interview, July 2009). However, as is reflected in this study's findings, trialling activities does not automatically result in mastery experiences and increased teacher efficacy. Citing Nespor's (1987) study, Brand and Wilkins (2007) explain that:

> […] negative and positive past experience influenced teachers' decisions about their instruction and classroom environment. If the experience had a positive impact on them, they would be more likely devoted to it or some form of it; and, if it had a negative impact on them, they would more likely avoid it. (p.298)

Cara and Tom who stopped trialling the activities – where experience of enactive mastery remained elusive – reported negative experiences whilst teaching. The reasons causing the case study teachers' negative experiences are reflected elsewhere in the literature. For example, Cara reported a lack of time whilst teaching the activity corresponds with Ross and Mason's (2001) research findings. Tom noted managing students and resources outside as a barrier; Mulholland and Wallace's (2001) study echoes this impediment. However, all the case study teachers expressed at some point a difficulty or barrier, though responses varied. Hence a negative encounter cannot be simply said to result in withdrawal from the programme.

'Depressed efficacy', described in Section 7.3.4, is a phenomenon documented in the literature resulting from an onset of efforts to shift practice (Bruce and Ross, 2008: 360). Bruce and Ross (2008) describe a teacher in this circumstance as becoming consciously incompetent. That is, often referred to as cognitive dissonance, following a professional development session/input, a teacher is aware of their shortcomings or where aspirational level increases faster than ability. Both states can be a result of professional development programme input (for example, modelling, theory presentation) followed by an initial attempt. In this research, for example, Charlie found managing students' learning outside challenging (see Chapter 6 for Charlie's case study). However, in Charlie's case, which resonates with Bruce and Ross's study, depressed efficacy was reported as being only temporary, the side-effect of a newly introduced pedagogy, overcome eventually through reflective practice. However, for some teachers, such as Cara and Tom, I suggest that the feeling of depressed efficacy was not overcome. Rather, the potential for repetition of the negative experiences was circumvented by initially omitting the particular teaching strategies, leading to the eventual abandonment of lesson trialling.

It is here, perhaps, in the space between depressed efficacy and recovery, that the influence from teachers' beliefs might be identified. So, although having the ability to identify success *per se* provides efficacy information (Skaalvik and Skaalvik, 2007), the ability to recover relates to several factors. First, the teachers' knowledge of the underlying theory and its relationship with practice; second, the teachers' beliefs concerning teaching and learning and how these beliefs correspond to those underpinning the professional development programme; and third, the teachers' ability to reflect, that is reflection in and on action (Schön, 1983). Chapter 9 discusses the interplay between teacher beliefs and professional development strategies.

A final point arising from trialling lessons, relating to teacher efficacy and collective efficacy, was the students' response to the activities. Although students were not a focus of this thesis and hence did not constitute a planned data source, lesson observation revealed students' reactions to the activities. Furthermore, participants commented on their perception of the students' experience during their interviews. In the main, these responses related to student enjoyment and student learning. This factor – students' responding positively – was an influencing factor on the programme especially on the repetition of particular teaching approaches. Guskey (1986, 1989) postulated that teachers observing positive student learning significantly had their beliefs influenced, eventually changing their practice. Perhaps students' feedback informs teacher efficacy, as a source of enactive mastery experience (Palmer, 2011). However observing positive reactions from students may take time. That is, beyond the superficial student reaction to the novel situation, time is essential if positive student learning is to be observed from teaching skills including group work, scientific observation and coping with cognitive conflicts outside. Hence as previously acknowledged, a significant strategy of the professional development was its extended duration.

8.3.2 Science department: working with colleagues

The second in-school factor that emerged to influence teachers' practice was working with colleagues. With one exception (Michael), all the case study teachers worked with a colleague at some stage of the two-year programme. Only one pair of teachers – Claire and Charlie – were consistent in working together over the programme's entirety. Table 8-4 summarises the case study teachers' professional development programme colleague relationships.

Table 8-4 Summary of case study teachers' relationships with colleagues concerning the programme

Case study teacher	School colleagues: relationship and length during programme
Michael Bison	None - in Year 2 a mathematics colleague joined the programme however there was limited interaction.
Cara Brown	Formally no colleague participated in the programme. Informally the head of department took an active interest. Also a member of the senior staff team, the head of department departed the school during Year 1. Resources shared with newly qualified teacher mentored. Programme briefly discussed during a department INSET.
Charlie Pence	Consistently worked with Claire Westwood. He considered himself as having less experience than Claire, seeing her departmental responsibility as useful in allowing them to fully participate in the programme.
Tom Peterson	Commenced the programme with a colleague (Zara) who he had had limited interaction with. The colleague left programme following Year 1 due to other commitments.
Megan Thomas	Encouraged a colleague with less experience in working outside to participate. Colleague left the school during Year 1. Encouraged her student teachers to trial the activities. Presented programme pedagogy to colleagues, through department and school-wide presentations.
Claire Westwood	Consistently worked with Charlie Pence. Encouraged department colleagues to trial activities with Year 9 classes. Short department talk given – generally work with colleagues individually on activity implementation.

How effective colleagues were at working together was influenced by the type of relationship they had. That is to say, collegiality appeared to have had a positive influence, as did a colleague's status, in the form of teaching responsibility or teaching experience. Collegiality was one factor that enabled Charlie and Claire's relationship to be beneficial to their professional development. However as Hargreaves (1994b) notes, collaboration cannot be forced ('contrived collegiality'). This factor might explain why, when an opportunity was presented to Michael to work with a mathematics colleague in his school, failure was due in part to his lack of initial involvement in selection of the relationship.

Alongside collegiality, Charlie acknowledged that his development had benefited from his colleague's status in the department. Busher and Harris (1999: 308), commenting specifically on heads of department, note the importance of 'power over' others which 'brings about improvement in practice'. None of the participants were heads of department, however Claire's and Megan's department responsibilities and teaching experience were acknowledged to constitute some 'power' over colleagues. For example, Claire, in-charge of Key Stage 4 Science, was able to adapt schemes of work, providing opportunities in the department for colleagues to teach the programme's activities. Charlie felt this 'power' made it easier for him to trial the activities as opportunities were created. The role that collegiality and colleague status played in the successful implementation of the programme can be observed in the following extract:

> It would be very different if it wasn't Claire I think, because she is very good at all the kind of leadership things, so she has been very good implementing the lessons within the department. And she's had the sort of clout to do that, and she's led the GCSEs so she can say we can do these [activities]. She's got quite a big influence on Key Stage 3 staff, she's got a management position, so she can put her opinion across. I think I would have found it more difficult to do that. And we share resources, we share ideas, we talk about all the lessons that we've done, and what worked, and what was more difficult. So we can feedback that way with each other. I would have found it a lot harder if I didn't have a colleague to work with on it. It would have been completely different. I wouldn't have tried so many lessons, I wouldn't have taught so many of the lessons.
> (Charlie, Interview, June 2009)

A number of benefits were identified from the case study teachers working with colleagues. First it led to enhanced motivation, second it offered a wider range of perspectives and third knowledge of contexts could be shared. All three affordances are considered below.

8.3.2.1 Motivation

Charlie, in the extract above, articulated the potential motivating effect that working with a colleague offered. For example, not only were programme activities prioritised due to Claire's status, but the relationship acted as a catalyst to trial new ideas and develop lessons following shared lesson evaluations. For the majority of participants working outside, finding new sites necessitated encountering a decrease in confidence (see Section 7.3 for a discussion of teacher efficacy outside the classroom). Trialling activities alongside a colleague made it easier - being recognised as 'fun' – sentiments expressed in the following extract:

> I think Zara was a bit more apprehensive than me, and I think she was a bit more confident in having a go at things when she'd seen that I'd had a go at it. Or if I said – yeah, I'll come to the park with you. Because I went to the park with one group, and then Zara and myself went together, I think then she felt more comfortable to do it herself. And it meant we could talk about it, we could develop resources together. I think having other people that are in the same boat as you makes you do it, otherwise you'd just be like – oh bugger it I can't be bothered.
> (Tom, Interview, June 2009)

It was noteworthy that when Tom's colleague stopped participating in Year 2, his involvement in the programme decreased substantially. Tom's reflections and the resulting outcomes resonate with Adey's (2004) assertion that, 'No one individual, however well motivated and energised can maintain a new method of teaching if she or he feels isolated' (p.166).

8.3.2.2 Different perspectives

The opportunity for different perspectives was the second theme identified as a reason why the participants felt it was beneficial working with colleagues within school on the programme. Cara noted that multiple perspectives offered a broader view of teaching approaches. She, for example, felt her 'creative side work[ed] overdrive', whereas a colleague's 'more logical side' would come in and question her by offering alternatives (Cara, Interview, June 2009).

Teachers' perspectives are informed by their beliefs. How the programme sessions were interpreted and translated was partially due to these 'belief filters'. Working alongside a colleague potentially offered, not one, but two 'belief filters' or perspectives. Understood as social constructivism, teachers sharing their understandings of the activities and programme sessions offered an accelerated opportunity for learning. That is, although lone teachers eventually might come to these different perspectives and understandings of the activities, working with other teachers potentially made these ideas more accessible.

8.3.2.3 Knowledge of school-context

The third benefit of working with a colleague identified by the teachers was a shared knowledge of the school context. The importance of teachers' knowledge of context was acknowledged in two of Shulman's (1987) seven distinct knowledge bases as 'knowledge of characteristics of the learners' and 'knowledge of education contexts'. It can also be recognised in Barnett and Hodson's (2001) pedagogical content knowledge model as 'classroom knowledge'. Hence, due to the specificity of context knowledge, colleagues exposed to the same environment are often considered more able to advise and support than other teachers outside. A point articulated by Cara:

> I know we shared that idea in the CPD anyway, but within our school there's obviously differences between how we would do things and other schools do things, and how we order equipment, and how we can use lesson time …
> (Cara, Interview, June 2009)

Here Cara was expressing the importance of shared knowledge concerning departmental systems and school policies. Another important factor was shared knowledge of outdoor space: specific locations, for example, to gather and talk to a group and where good examples of specimens had been identified. A final factor was a shared knowledge of specific students' needs. An example of this factor was observed when Claire and Charlie shared a Year 9 class comprising several students with challenging behaviour. With reference to this class, Claire reported that it was Charlie's experiences that informed her planning:

> [We] also talk about how you would actually do the lesson and especially with this (Year 9) group, with groups that we share being able to think about how they will respond to those different things on that level as well as just the lesson as a whole.
> (Claire, Interview, March 2009)

The discussions referred to above, facilitated reflection and, it could be argued, acted as a source of teacher efficacy in the form of verbal persuasion (Bandura, 1997).

8.3.3 Science department: programme tutor lesson observation/feedback

A programme tutor observed participants teach the activities on at least two occasions. Similar to the affordances identified in working with a colleague on the programme, the case study teachers articulated the benefits of tutor visits as providing motivation to teach and evaluate the activities between programme sessions. Claire referred to the tutor's visit as 'an intervention in-between every session' giving the programme a sense of continuation between session and school: 'So it's kind of been a continuous thing rather than being a 'that's today' and then going off, 'goodbye - hope it works' kind of thing' (Claire, Interview, May 2009).

However, compared to working with colleagues, case study teachers commented only occasionally on tutor visits and feedback. This finding contrasts to Palmer's (2011) study and the CASE programme (Shayer and Adey, 2002) that report 'in situ feedback' as a major factor of influence within the interventions. The differences between the findings were arguably due to the observation/feedback aims. For example in Palmer's (2011) study, feedback was used to 'provide encouraging comments to teachers' (p.594) serving as a source of verbal persuasion. The observer was positioned as 'an expert'; a person considered to be specialised in the field. For the current study, teacher-tutor discussion following the observed lesson focused on the suitability of the activities rather than the individual teachers' accomplishments. A balance of power was attained. That is, the teacher was acknowledged as an expert concerning the students' responses and lesson practicalities, whereas the tutor had a deeper understanding of the programme's theoretical foundation and had observed the activities being carried out across multiple contexts.

8.3.4 Science department: dissemination

Participants were encouraged to share with colleagues the programme activities and the pedagogical framework. They undertook this task using a number of methods resulting in a range of outcomes. The majority of case study teachers shared the resources via the school intranet. However, most reflected that further encouragement was essential if colleagues were to trial them. Department meetings were considered the most opportune time for dissemination, however participants felt that meetings suffered from a lack of time to do real justice to the programme's activities.

Claire and Megan judged themselves as successful in disseminating activities with colleagues. Claire's approach was to incorporate the activities into the Year 9 scheme of work during a period traditionally set aside for post-National Curriculum exam lessons. This process enabled colleagues to become familiar with the activities without any additional pressures. All teachers of Year 9 classes were directed to trial the activities, with Claire ordering all the resources for the classes. Claire noted that she talked to teachers individually about specific lessons – in doing so explaining how they linked to CASE. This might be considered a form of peer-coaching, which currently is unproven as a strategy to change the practice of colleagues not attending a professional development programme (Guskey and Yoon, 2009). That aside, for the disseminator – in this case Claire – the process offered sources of cognitive mastery and emotional/psychological experiences. For example, discussion and presentation of new ideas to colleagues offered emotional-related experiences. Claire invested time and showed commitment and passion in setting up and discussing the activities with colleagues. Furthermore, cognitive mastery experiences might have been available through the explanation of the different pedagogical stages required by the activities, in that she was required to re-consider the theoretical foundations to support their rationale (Palmer, 2011).

8.3.5 Summary

Table 8-5 presents the three emerging in-school strategies/factors that appeared to have influenced the case study teachers' practice. These were trialling activities, working with colleagues and dissemination of programme resources. From these three factors, teachers cited trialling activities as most influential on practice – potentially offering opportunities for enactive and cognitive mastery experiences. Also emerging was the requirement for persistence to practice the activities over an extended period of time. When this opportunity arose, teachers' practice was judged to improve. This final point relates to Chapter 7's discussion concerning teacher efficacy is returned to briefly in Chapter 9.

Table 8-5 A summary of in-school professional development factors/strategies influential on case study teachers' practice

In-school: Factor/strategies	**Influential aspect of factor/strategy**	**Reason for influence**	
		Teacher efficacy related	**Practical/motivational related**
Trialling activities	Frequently trialling a range of activities	Enactive mastery experience	Familiarity
		Cognitive mastery experience	
Working with colleagues	*Type of relationship:* 'Collegial'	Verbal persuasion	Motivational Different perspective Knowledge of school-context
	Colleague with 'status'	Verbal persuasion	Providing opportunities Different perspective Knowledge of school-context
Science department dissemination	Activities placed into SoW/ individual discussion with non-participating colleagues.	Cognitive mastery Emotion/psychological experience	Provide opportunities Motivational

The second factor – working with colleagues – was most effectual in situations where collegiality between teachers existed or where one of the pair held a post of responsibility. The benefits of working with a colleague were identified as motivational, offering different perspectives and having a shared knowledge of the school context. Departmental dissemination, the third in-school programme strategy found to have a positive effect on teachers' practice, was thought to offer an opportunity for reflection on theory and practice. Looking across the programme's duration it is evident that professional development strategies/factors became influential on teachers' development at different stages. This finding concurs with those of Bruce and Ross (2008) who identified that as teachers practice improved, their efficacy increased, and an adjustment in the importance of professional development strategies was reported. That is, as teacher efficacy increased, sources of efficacy changed. So by comparing how the case study teachers evolved over the programme it is evident that trialling activities was initially the most important in-school source of teacher efficacy. Once teacher efficacy increased, working with colleagues and department dissemination became an important teacher efficacy source. Bruce and Ross (2008:364) acknowledged this gradual change in teacher efficacy sources as ‘a reflexive and reciprocal growth process […]’.

8.3.6 Professional development: other social settings

Professional development strategies discussed in Sections 8.2 and 8.3 were grouped according to their association with contexts. Therefore the final professional development strategies influencing practice are broadly identified as ‘other social settings’. These were: writing a reflective journal and presenting at conferences.

As discussed earlier, in Chapter 4, all the participating teachers received a journal to record their reflections on the activities. A list of questions, to guide reflections, accompanied the journal (Appendix 4). The majority of participants did not maintain the journal; Cara was an exception. During Year 1 the journal promoted Cara to trial the activities:

> The fact that you’d gone to the trouble of giving us those notebooks to write everything in as well, and I wanted to have something written in it by the time I came to see you again. I think that did encourage me to try it out, yeah.
> (Cara, Interview, June 2009)

For Cara, it was the journal’s audience, perceived as external and a group to satisfy, which gave the journal significance. Furthermore, Cara’s perception of the requirement of evidence for future programme sessions acted to motivate her to trial the activities. This role – as a reminder or motivator – was similarly assigned to ‘props/resources’ (as discussed in Section 8.2.1.2) and working with a colleague (as discussed in Section 8.3.2). All three examples highlight the importance of the physicality of an object to prompt action.

In the professional development sessions all participants were invited by the programme tutors to co-present at education conferences (for example, Association of Science Education

National and Regional conferences). Claire, responding to this offer, discussed her potential participation with programme tutors. Participating in conference presentations is similar to dissemination to department colleagues (Section 8.3.4). That is, the teacher becomes an advocate for the professional development programme. However, this finding is speculative and informed solely by my own impressions. Claire did not identify conference presentations in the interviews as a professional development activity. This might be due to it not serving this role, however it is more probable that conferences were not associated with the more traditional view of professional development (Friedman and Phillips, 2004). Whilst substantiated data is not available, I consider that discussing and presenting the programme to peers offered emotional-related experiences as well as cognitive mastery experiences (Palmer, 2011).

Table 8-6 A summary of 'other-settings' professional development strategies influential on case study teachers' practice

Other social settings: Strategies	**Influential aspect of strategy**	**Reason for influence**	
		TE related	**Practical/motivational related**
Reflective journal	Writing The object		Concrete reminder
Presenting at conferences		Cognitive mastery experiences Emotional/psychological experience	

8.4 Chapter Summary

This chapter addressed the research question: What professional development strategies are significant in influencing teachers' practice? In an effort to answer this question, the different contexts for professional development were explored, such as in school and other settings. Table 8-1 summarised programme session strategies considered to have influenced teachers' practice. These were how the activity was introduced, whether resources were distributed and the involvement of teachers during sessions. These strategies were identified as either sources of teacher efficacy or motivation. Sources of teacher efficacy included cognitive mastery experiences, vicarious experiences and verbal persuasion. Table 8-2 summarised strategies specific to the study's programme – 'Thinking Beyond the Classroom' – to have influenced practice. The four principles of the professional development programme's framework, plus management of students, were not equally observed in practice or discussed in interviews. Principles of the framework most frequently observed in practice had been introduced through two common strategies: tutor-led simulated modelling and theory/practice discussion. Both strategies were not used when other less frequently observed pedagogical principles were introduced.

In school, the most influential strategy was identified as trialling a range of activities, frequently, over an extended period of time. It was suggested that trialling activities offered opportunities for enactive and cognitive mastery experiences. Working with a colleague appeared influential especially where collegiality was identified or one participant held status within the department. The final strategy was departmental dissemination, which offered an opportunity for reflection on theory/practice and verbal persuasion. 'Other settings' included presenting at conferences and reflective diaries. Conferences and reflective diaries were acknowledged less by the case study teachers as influential on practice compared, for example, to trialling the activities. This was perhaps due to the lack of uptake and the non-traditional professional development strategy they presented. Their influence was aligned to opportunities offered by other professional development strategies/factors such as departmental dissemination and receiving professional development resources. However a further exploration is required of the potential role 'other settings' has in professional development programmes on teachers' practice.

This chapter's findings stress the individual nature of teachers and their contexts in terms of the influence of colleagues and communication in schools despite there being a common context of a National Curriculum and a professional development programme. Influential strategies and factors were noted as those that provide multiple sources for teacher efficacy enhancement and motivation. Chapter 9 returns to the subject of the individual teacher to consider whether particular beliefs and teacher efficacy have additional influence on the uptake of professional development opportunities.

Chapter 9 Discussion, Implications and Conclusion

9.1 Introduction

This thesis set out to explore the relationship between a two-year professional development programme concerning teaching outside and participating secondary science teachers' beliefs and teacher efficacy. Three research questions formed the core of the study. These were:

1. What is the interplay between teachers' beliefs, teacher efficacy and pedagogical practice?
2. What professional development strategies are significant in influencing teachers' practice?
3. How do teachers' beliefs and teacher efficacy influence responses to professional development programme strategies identified as significant in changing practice?

This final chapter consists of five sections. Section 9.2, summarising Chapters 7 and 8, presents the key findings for research questions (RQ) 1 and 2 before turning to RQ3 to discuss how teachers' beliefs and teacher efficacy influenced the teachers' responses to professional development programme strategies. Section 9.3 discusses the implications of the findings as they apply to practice and theory. Section 9.4 extends the discussion of methodological issues first discussed in Chapter 4. The study's limitations are discussed as is the extent to which the research findings can be generalised. As this thesis has highlighted the complexity in understanding the relationship between science teachers' beliefs systems (Jones and Carter, 2007) and teaching science outside, the final section (9.5) outlines future research questions recognised as being critical to continue this endeavour.

9.2 Discussion of key findings

9.2.1 Interplay: teachers' beliefs, teacher efficacy and pedagogical practice

Addressing RQ1, Chapter 7 explored the interplay of the case study teachers' beliefs, teacher efficacy and pedagogical practice. The chapter examined the separate constructs, teacher beliefs and teacher efficacy, and their relationship with practice, prior to a broader examination of their interrelationship. There are four main findings which are discussed in turn below.

Finding 1: Teachers' beliefs concerning how children learn appeared to influence their beliefs concerning teaching and learning outside and their subsequent pedagogical decisions

The programme's pedagogical framework was built on the belief that student learning can be interpreted through a social constructivist lens. Based on the relative effectiveness of teachers' implementation of this framework, the six case study teachers were divided into two broad groups – *more successful* and *less successful*.

A relationship was identified between the beliefs that underpinned the design of the professional development programme and those held by the case study teachers about learning. There was evidence to suggest that the closer the teachers' beliefs were to those informing the programme, the more likely they were to implement the programme's pedagogical approaches. Furthermore, the teachers' views of learning appeared to be related to the likelihood that their practice outside might change over the two-year programme. For example, Claire and Charlie, judged by the end of the programme as *more successful* implementers of the programme's pedagogy, were identified as having social constructivist beliefs about learning. Conversely, Tom and Michael, judged as *less successful* implementers of the programme's pedagogy, appeared to hold behaviourist/traditional approaches to student learning. However there were exceptions: Cara, whose implementation of the programme was *less successful*, was judged as having social constructivist beliefs about learning. Finding 3 below discusses this inconsistency suggesting teacher efficacy as a possible reason.

Case study teachers' beliefs about how students learn appeared associated with other beliefs such as: how the participants felt about teaching and learning outside, science epistemology, the purpose of science education and the management of student learning outside. Using Rokeach's (1968) analogy, it was proposed that beliefs about how students learn might be considered as 'core', and the latter beliefs – how the participants felt about teaching and learning outside, science epistemology, the purpose of science education and the management of student learning outside – as 'peripheral'.

A key focus for the study's programme was to develop teachers' pedagogical practice whilst outside. Table 7-1 summarised the different beliefs about teaching and learning outside, comparing teachers categorised as *more successful* and *less successful* implementers of the programme's pedagogical framework. The findings suggest that *more successful* teacher implementers – generally associated with holding social constructivist teaching approaches – valued students developing multidimensional relationships with their surrounding environment by learning in it (for example, an everyday relationship, a science relationship, an art relationship); whereas teachers considered *less successfu*l implementers – in general associated with traditional/behaviourist teaching approaches – did not. More specific to science learning, the *more successful* implementers valued the opportunity for learners to develop their abilities to transfer and extend science knowledge in different contexts. For these teachers, the outdoors was considered a very important starting point in a journey towards understanding the 'natural world'. A comparison can be made between these teachers' beliefs and those judged as *less successful* in programme implementation. The latter group did not differentiate the learning potential offered by the outdoor context; situating it more generally as another learning 'tool', 'resource' or 'opportunity'. Furthermore, *less successful* implementers often assigned an inferior status to learning outdoors by restricting activities to review tasks only; science curriculum learning being entrusted to inside the classroom.

More successful implementers' beliefs about teaching outside were pragmatic whilst being positive. For example, they tended to believe that students had to be explicitly taught to learn outside and that planning lessons was essential to achieve success. These beliefs compare positively with those teachers judged as *less successful* as, whilst being pragmatic, this latter group of teachers were generally more negative – usually highlighting barriers without suggesting solutions. For example, both groups of teachers identified many things that could go wrong during lessons outdoors and both groups noted that extra planning was essential. However, where *more successful* implementers discussed the affordances in terms of learning resulting from the extra planning, *less successful* implementers focused on the extra administrative burden and identified time as a limiting factor.

Finding 2: Teachers' subject discipline appeared to have limited influence on their beliefs concerning teaching science outside

In the past, outdoor science has been more widely affiliated with biology rather than chemistry or physics, due to its association with ecology and natural history. Hence biology specialists (those with biology or biology-related degrees and/or teaching post-16 biology courses) were, traditionally, perceived to be more able, likely and confident to teach using the outdoors than chemistry and physics specialists. This assumption was consistent with the findings of Ross (1998) who identified subject specialism as highly influential on teacher efficacy and Cantrell *et al.* (2003) who found that a decline in subject content knowledge led to a decrease in teacher efficacy. In this small-scale study, a mixed picture emerged; biology specialists were not found to have more effective pedagogy or higher teacher efficacy than teachers with physics or chemistry backgrounds. However, it appeared that teachers themselves shared the view that biologists were more likely to be proficient in the outdoors and this belief influenced their teacher efficacy. For example, in Year 1 of the programme, Claire (a chemist), associated biology teachers with the outdoors and believed they had special training to teach in that context. It is possible that this belief undermined her teacher efficacy as, at the start of the programme, she was hesitant to teach outdoors. During Year 2, Claire's beliefs altered as she came to consider the outdoors as a good context in which to teach any science subject. This shift might have been a result of her teaching all science disciplines outside. As a consequence, her teacher efficacy increased.

Subject disciplines, however, appeared to have had an influence on several teachers' choices of activity. Although Michael (a physicist) and Charlie (a biologist) did trial activities from other science disciplines, the activities they taught most often were those associated with their own subject specialism even though they both taught general GCSE science (students up to 16 years-old). These decisions might relate to their teacher efficacy. That is, how good a teacher judges their subject knowledge to be, influences the type of activity chosen to teach when presented with a new context.

Finding 3: Teacher efficacy appeared to influence teachers' pedagogical decisions

Teacher efficacy appeared to influence teachers' pedagogical decisions. Its influence was consistently observed across a range of levels including high, low and moderate efficacy. Where high teacher efficacy was identified – Megan and Claire, for example – characteristics included a persistence to trial and adapt activities. This finding is consistent with Haney *et al.*

(1996), who found that teachers with higher teacher efficacy were more likely to learn new strategies and persist if initial implementations were flawed.

Teachers judged as *more successful* implementers of the programme had high, rather than very high, teacher efficacy. This finding was consistent with Wheatley's (2002; 2005) proposal that for pedagogical change to take place, some self-doubt was required. Furthermore, those case study teachers identified as possessing high teacher efficacy might be described as having 'pedagogical discontentment' – that is, being critical of their practice and open to change – a requisite, Sutherland *et al.* (2011 a & b) have argued for pedagogical change. Both theories, rooted in teacher efficacy, are consistent with Bell and Gilbert's model of teacher development that proposed that the first stage of personal development was 'accepting […] a professional dissatisfaction or problem' (1996:16).

In line with Pajares' (1996) findings, low teacher efficacy appeared to be detrimental to case study teachers' pedagogical development (for example, Cara). As noted earlier (see Finding 1), although teachers may have beliefs similar to those underpinning the programme, it emerged that low teacher efficacy may undermine efforts resulting in teachers giving up prior to significant practice being completed to enable change.

Finally, this study identified two teachers who had moderate teacher efficacy during Year 1 but who responded differently to the professional development programme. In one case, practice improved (Charlie), in the other, practice stasis occurred (Tom). Acknowledging that qualitative teacher efficacy research is in its infancy (as discussed Section 3.5), an as yet under-reported/identified group are those teachers judged as having moderate teacher efficacy. One explanation for teachers with moderate teacher efficacy having different practice outcomes relates to their estimation of the task demand; or as Bandura (1977) conceptualised it, 'outcome expectancy'. Outcome expectancy is one of two factors that make up teacher efficacy, the other being perceived efficacy (as discussed in Section 3.4.3).

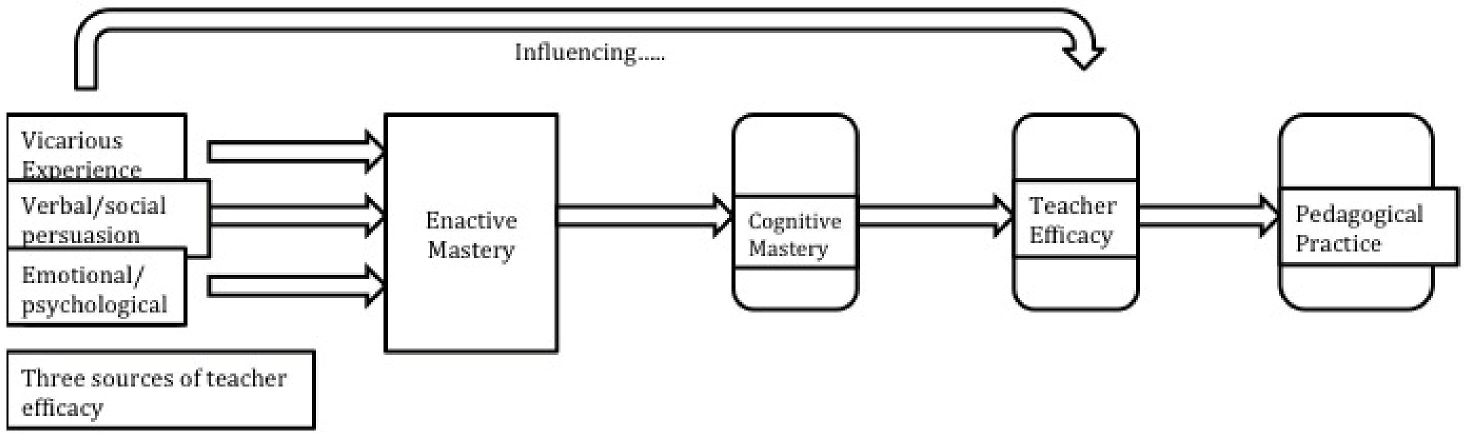
Bandura (1977) posited that outcome expectancy was informed by action-outcome contingencies based on life experiences. For example, relevant experiences for the case study teachers might include knowledge of CASE or teaching/learning science outside. The assumption is that the greater a teacher's relevant experiences, the more 'realistic' their outcome expectancy (realism, however, is acknowledged as contested). For this study, the potential role that beliefs serve in the formation of outcome expectancy is an important issue which brings to the fore the interrelationship between components within the belief system and the difficulty with which they can be separated.

Returning to the influence of outcome expectancy on teacher efficacy and pedagogical practice, a teacher with CASE experience and pedagogy characterised as falling within the social constructivist perspective might be considered a better judge of future attainment compared to a teacher without these qualities. That is to say, the less experienced teacher, in underestimating tasks, 'produces errors in the direction of apparent over assurance' and therefore 'insufficient allowance for likely impediments may yield overconfident judgement' (Bandura 1997:64-65). It can be said that outcome expectancy influences teacher efficacy judgements, which influence pedagogical decisions, resulting in particular pedagogical outcomes (see Figure 4).

A second, but related, explanation for different pedagogical outcomes for teachers with moderate teacher efficacy is associated with how they perceived their own teaching. Where the experience was generally considered positive, a sustained effort to trial activities was reported (Charlie), whereas where the experience was generally considered negative, efforts decreased leading to a discontinuation of the lessons (Tom). So whilst Charlie had numerous opportunities for practice change, Tom's opportunities were restricted and his practice remained the same. Why the teachers experienced the activities differently may relate to the explanation above concerning the range of outcome expectancy.

Teachers identified as having moderate teacher efficacy might be more susceptible to change in both practice and level of efficacy than teachers with high or low efficacy. Teachers with moderate teacher efficacy might be more likely to exhibit positive changes in practice where their beliefs are sympathetic to those underpinning the programme and they are willing to continually practice new strategies.

Figure 4 A model representing the interrelationship of the sources of teacher efficacy on pedagogical practice



Finding 4: Beliefs and teacher efficacy relating to managing student learning outside appeared to influence teachers' pedagogical decisions

Beliefs relating to how children learn and how they should be taught appeared to influence all teachers' beliefs and practice concerned with managing student learning outside. Teachers who exhibited more social constructivist views in their teaching approach appeared (eventually) to be more proactive than teachers using traditional approaches in developing student outdoor group work skills. The result being that, for this group of teachers, the necessity to manage student learning outside decreased as students became more able to manage themselves.

However, teacher efficacy concerning the management of student learning outside influenced all the case study teachers. For the majority of the participants, the evidence from my observations and teacher self reports suggested that feelings concerning managing student learning had a negative influence on teacher efficacy, which in turn influenced pedagogical decisions. This pattern was particularly evident during Year 1 when strategies and contexts were new. For example, Claire's outcome expectancy in Year 1 was that when outside, students would become distracted and behave poorly. Hence her teacher efficacy was 'depressed' (see Section 7.3.1). The outcome of lowered teacher efficacy for several case study teachers (for example, Claire, Charlie and Cara) was that teaching practices outside, at the beginning of the programme, were more 'traditional'. However, in two of the three cases (Charlie and Claire), when their judgement about their own ability to manage students was not borne out in practice, their teacher efficacy increased and social constructivist teaching practices gradually shifted from the classroom to the outdoors.

Chapter 7 tentatively drew on Foucault's (1977) and Bernstein's (1990) work in an effort to explain the findings above. Foucault's proposal that 'discipline proceeds from the distribution of individuals in a space' (1977:141), enables some understanding as to why, when the context (space) is new, teachers might feel initially apprehensive due to the uncertainty presented by the routines and rituals of working outdoors. Furthermore, Bernstein's (1990) framework of discourses might explain why teachers initially adopt traditional approaches when encountering the outdoors. That is, when entering an unknown teaching space/context, new rules and comportments need to be formulated, shared and practised. Regulative Discourse, which is something implicit in many teachers' practice, needs to become explicit. Hence, students are told exactly what is to take place and rules are articulated. I suggested (in Section

7.2.4) that Regulative Discourse – focused on rules and procedures – has much in common with traditional teaching approaches. Once the procedures are created and understood they become implicit in practice, enabling the teacher to become more concerned with Instructional Discourse and enabling teaching approaches more in line with beliefs about how children learn.

9.2.2 'Thinking Beyond the Classroom' programme factors influencing practice

Chapter 8 set out to identify strategies of professional development strategies significant in influencing teachers' practice. Two levels of response to the question emerged from the data. These were, 'strategies' relating to contexts (Finding 5) and the reasons for the strategies' influence (Finding 6).

Finding 5: Both programme sessions and in-school strategies were required for pedagogical change

This study reaffirmed that both professional development programme sessions and in-school strategies were required for pedagogical change. This finding supports other research studies that have called into question the worthwhileness of the professional development 'one-shot' session deficit approach (Adey, 2004; Day and Sachs, 2004; Hodkinson and Hodkinson, 2005). If professional development is seen as multi-dimensional (Bell and Gilbert, 1996), then the interrelationships between form and content requires acknowledgement.

As anticipated, following the discussion in Chapter 2, this study's analysis found that identifying isolated influential factors informing beliefs and pedagogical change in the complex contexts of education was challenging. For example, in the programme session, both tutor-led simulated modelling strategies – teachers acting as the student and tutors as teacher – and the distribution of props/resources were acknowledged as influential on teachers' practice. However, it was not until teachers were able to trial the activities, using suggested ideas and new resources, on multiple occasions within their school contexts that change occurred. Therefore, it was the combination of the factors, from the sessions and in school, which appeared to influence practice.

Evident in this study was the role that colleagues played in an individual teacher's development. Colleagues were found to act as a bridge between the programme sessions and the school. Colleagues were acknowledged as a stimulus to trial activities, a source for reflection and a reliable reminder of the original content of the programme. Shulman and Shulman (2004) similarly noted the importance of collegiality for successful individual development, proposing that the most successful relationships nurtured risk-taking. Evident in this study was not only the importance of collegiality but also the role 'status' played. Extending Shulman and Shulman's (2004) findings, I propose that colleagues with 'status' – someone having department responsibly – might have more potential to create the supportive environment essential for a more junior colleague's 'risk-taking'.

In a related study of factors enabling science teachers use of the outdoors, a colleague and I identified the requirement for a 'learning experience organiser' for successful outdoor learning within a department. The organiser was described as 'an enabler who is looking for opportunities to enrich their own and their colleagues' science teaching' (Glackin and Jones, 2012:112). This type of teacher contrasts with Joyce and Showers' (2002) 'Gourmet Omnivores' – described as a highly-active person who has learned to canvass the environment and successfully exploit it. That is, where the Gourmet Omnivore was presented as a teacher interested in their own professional development, the enabler is equally concerned with their colleagues' professional growth – acknowledging it as a means to their own development.

Finding 6: Strategies influential on practice may act as a source of teacher efficacy or motivation

Finding 5 proposed that multiple contexts for professional development strategies were required for pedagogical change. In Chapter 8, reasons for the strategies/factors to have been influential were proposed as either teacher efficacy sources or motivation sources. Table 8-1 and Table 8-2 indicated that not only did the programme offer all four (or five, if cognitive mastery is separated from enactive mastery) sources of teacher efficacy, but that those strategies could be considered influential on teachers' efficacy. Previous research has frequently identified that of the four sources of self-efficacy, mastery experience has the greatest impact (Bandura, 1986; Tschannen-Moron, Hoy and Hoy, 1998). This finding led to Tschannen-Moran and Woolfolk Hoy proposing that teachers' professional development should 'be structured as powerful mastery experiences' (2001:803) on the premise that teachers were required to 'garner evidence of improved learning on the part of their students in order to reap the efficacy pay-off that would result' (*ibid.*). However, in line with Brand and Wilkins (2007) and Bruce and Ross (2008), although my findings suggest that mastery experiences were important, the significance of the other teacher efficacy sources could not be dismissed.

Accepting Palmer's (2011) theory that two dimensions of mastery experience are identifiable – enactive and cognitive – my findings indicate, building on Brand and Wilkins' (2007) proposal, that the other three teacher efficacy sources – vicarious, verbal/social persuasion and emotion physiological – not only act directly on teacher efficacy but, mediated by the enactive mastery experience, influence cognitive mastery experiences (see Figure 4). So although enactive mastery experiences are a requirement, ultimately it is the cognitive mastery experience, rather than enactive mastery, that influences teacher efficacy and pedagogical practice. For example, hearing about the pedagogical framework (verbal persuasion) might act immediately on a teachers' judgement about their ability to teach outside (their teacher efficacy) whilst informing their perception of 'success' when teaching the activities (enactive mastery). The outcomes from teaching (enactive mastery) may then inform their perceived understanding of the pedagogy (cognitive mastery). My findings also concur with those of Bruce and Ross who noted that 'efficacy information from mastery experiences was strengthened because the other three sources of efficacy were more readily available' (2008:360). For example, in the programme session when vicarious experiences – through tutor-led simulated modelling – were omitted, being replaced by reading-only activities, teachers were less likely to trial the activity. This reluctance was possibly a result of lowered teacher efficacy due to the lack of vicarious experience.

Strategies considered as sources of motivation (or motivators) for teachers could be categorised into those initiating a will to observe student responses (for example, novel practical ideas), and those enabling access to the activities (for example, National Curriculum links). I postulate that rather than just being an object or experience, this motivating item is instead representative of potential goals that the teacher might achieve. That is, in the former example, the goal might be to observe a positive response from the students when teaching; and in the latter case, the goal might be to cover curriculum content whilst developing new teaching strategies. The object/experience becomes a motivator only once the teacher has attached a goal to it. For example, the teacher may experience a novel activity during the professional development session and believe their students' will benefit from undertaking it. Hence, I suggest that 'motivators' might have contributed to teacher efficacy. That is, they acted to inform the teachers' goals, and, therefore, outcome expectancy. Bandura wrote extensively about motivation processes and their relationship with the efficacy belief system (see Bandura (1997) and Section 3.2). However, my proposal that objects/experiences might offer latent outcome expectancy stimuli has not been commented on in previous studies.

9.2.3 Teachers' beliefs and teacher efficacy influence on programme outcomes

RQ2 concerned professional development strategies/factors significant in pedagogical change across the six case study teachers. A range of responses, however, was evident concerning specific programme strategies/factors, enabling some teachers to engage further whilst others withdrew. In Chapter 7, the condition 'depressed efficacy' (Bruce and Ross, 2008:360) was used in cases where teachers became aware of their shortcomings. Southerland *et al.* (2011b) referred to this internal conflict – the mismatch between pedagogical goals and teaching practice – as 'pedagogical discontentment'. It is proposed that depressed efficacy/pedagogical discontentment was caused by both learning about and trialling new pedagogy and teachers' beliefs and teacher efficacy. Combining the findings emerging from RQ1 and RQ2, the final research question sought to identify the influence from beliefs and teacher efficacy on the interpretation of programme strategies that resulted in sustained involvement or eventual withdrawal from the programme. Findings 7 and 8, below, address the question: How do teachers' beliefs and teacher efficacy influence responses to professional development programme strategies identified as significant in changing practice?

Finding 7: Teachers' beliefs appeared to influence their response to programme strategies that concerned children's learning and managing learning outside

In Chapter 7, beliefs about how children learn and how learning should be managed emerged as influential on teachers' pedagogical practice. It is unsurprising, therefore, that factors/strategies of professional development associated with these two beliefs, were considered significant in influencing practice. In terms of teachers' beliefs about how children learn, this study identified two broad groups among the case study teachers: those more aligned with social constructivist approaches and those more aligned with behaviourist/traditional approaches. In the programme sessions, all the teachers responded similarly to the range of strategies used except in the case of those that were most related to theories of social constructivism. These strategies emerged as only being significant to teachers identified with beliefs aligned with social constructivist teaching approaches. These strategies included: having a clear pedagogical framework – transferable to other lessons; authenticity of professional development programme – in both theory and the tutors; and, a tutor-led activity to develop teaching observation skills to students (see Appendix 25).

The second belief influencing teachers' responses to professional development programme strategies concerns management of student learning. All the teachers, to an extent, were concerned with managing students outside. A common belief was that managing learning outside the classroom was more challenging than inside. Hence, teachers responded positively when the programme's strategies directly related to managing student learning. They also appreciated when teachers led these aspects of the programme – as they were considered to offer grounded, practical advice and ideas. A final point concerning managing behaviour relates to teachers' beliefs about how children learn. In Chapter 7, teachers with beliefs aligned to social constructivist approaches were noted as being more receptive to strategies relating to student group-work skill development than teachers with beliefs more aligned to behaviourist/traditional approaches. For example, participants in the former group readily trialled group work strategies. One possible explanation for this finding was the perceived dual function that the programme strategy offered. That is, the strategy to develop group-work skills supported a social constructivist view of learning. In addition, the strategy placed responsibility to manage learning on the student, rather than on the teacher.

Finding 8: Teacher efficacy appeared to influence teachers' responses to trialled activities and working with colleagues

Shifting the emphasis from beliefs and professional development programme session factors, the final finding of this thesis concerns teacher efficacy and two in-school strategies/factors – trialling activities and working with colleagues. Unsurprisingly, all teachers reported that trialling activities were important for pedagogical change. However, the interpretation – reflection-on-action (Schön, 1983) – of the outcome of the trialled activities influenced future pedagogical practice with teacher efficacy mediating the interpretation. Hence, where teachers were found to have moderate-low teacher efficacy, they trialled fewer activities over the two years, compared to teachers with moderate-high or high teacher efficacy. Furthermore, teachers with moderate or moderate-low teacher efficacy during Year 1 were noted as being more likely than teachers with high teacher efficacy to trial activities more closely associated with their subject specialism even though they taught general science across Key Stage 3 and 4.

It was evident that working with colleagues had a significant influence on teachers' responses to the programme. Regardless of teacher efficacy, teachers were able to gain much from working alongside a colleague. However teacher efficacy might have mediated what they needed and were able to obtain from the relationship. For example, where colleagues were characterised as possessing moderate teacher efficacy and moderate-high teacher efficacy (for example, Charlie and Claire), the teacher with lower teacher efficacy gained the motivation to sustain effort and persevere whilst the teacher with higher teacher efficacy benefitted from the role as motivator. A mutually shared benefit was one of context knowledge, which included knowledge of the school grounds, departmental equipment and particular students. However, where Charlie and Claire's relationship was maintained – and considered beneficial – for the programme's duration, other teachers' relationships were not sustained. From the three other case study teachers who worked with colleagues on the programme prior to them leaving, only one was judged to remain fully engaged in the programme. The teachers who eventually disengaged were categorised as having moderate teacher efficacy at the start of the programme (Cara and Tom), whereas the teacher who maintained full engagement for the programme's duration, even though her colleague left, had high teacher efficacy (Megan). Adey (2004) notes that maintaining a new method, if the teacher is isolated, is challenging. Megan's high teacher efficacy might have enabled her to widely disseminate the programme messages among her department, maintaining her motivation and interest. Working with colleagues relates to collective efficacy. For example, for Charlie and Claire, a relatively high collective efficacy might be predicted. That is 'a group's shared beliefs in its conjoint capabilities to organise and execute the courses of action required to produce given levels of attainments' (Bandura, 1997:477).

In general, teachers with social constructivist teaching approaches and high teacher efficacy were more responsive to a wide range of programme strategies than teachers judged to hold beliefs more aligned with traditional teaching approaches and moderate-low teacher efficacy. That is, although all teachers responded to professional development session strategies, teachers in the former group implemented more teaching approaches from the programme sessions into lessons and created more opportunities for professional development within school (for example, trialling numerous activities, disseminating to the department) and other settings (for example, at conferences). However, in these cases, differentiating whether teachers' beliefs or teacher efficacy had a greater influence on their response to programme strategies is challenging; a combination of both components is likely.

9.3 Implications and recommendations

It has been proposed that teacher efficacy and teacher beliefs can influence, positively or negatively, outdoor pedagogical practice. This study explores the relationships between these three aspects – teacher efficacy, teacher beliefs and pedagogical practice – in the context of a two-year professional development programme of outdoor science. Section 9.3.1 sets out how the study's findings might enhance practice, or more precisely the professional development of teachers both in general and specifically for teaching outside. As recognised in Chapter 2, teachers' professional development is contributed to by multiple agencies, hence the recommendations in the first section are initially for teacher educator/programme providers and school professional development organisers (often members of school senior staff teams) but are equally useful for professional development policy developers in relevant organisations and government departments. Section 9.3.2 sets out implications and recommendations for three relevant areas of theory: qualitative teacher efficacy methods, general teacher professional development and, science teachers' outdoor pedagogical practice.

9.3.1 Implications for practice

9.3.1.1 Implications for teachers' professional development

From the study's findings, four groups of implications were identified for the enhancement of teachers' professional development at the level of the individual teacher (micro-level). The first group concerns teaching beliefs. The findings suggest that for professional development to have a significant influence on teachers' practice, programme designers should consider articulating the beliefs underpinning the programme theoretical framework. This strategy can be beneficial on two levels. Firstly, it offers teachers and tutors a shared understanding of the professional development's theoretical position, whilst enabling personal analysis of the divergence of individual perspectives/experiences. Secondly, if teachers' perspectives and experiences are collected, the programmes might be differentiated. For example, in grouping teachers based on their experience of CASE teaching, the sessions might be varied to ensure an appropriate balance between theory – such as, cognitive conflict and metacognition – and practice.

The second group of implications concerns teacher efficacy. The study's findings suggest that for effective professional development, an increased awareness of participants' efficacy as it relates to the programme promoted would be beneficial. Without due attention to perceived efficacy, and possible interventions, the professional development programme's influence on practice might be inhibited. Identifying participants with teacher efficacy at different levels could offer an opportunity for variations in approaches to be used. For example, concurring with Wheatley (2002; 2005) and Southerland *et al.* (2011b), this study found that teachers with high teacher efficacy were open to change. 'Pedagogical discontentment' among this group might therefore be encouraged. Opportunities could be offered to support change, as appropriate, for their teaching context.

Conversely, this study's findings suggest that teachers identified with moderate teacher efficacy might have a range of practice outcomes. That is, teacher efficacy might improve, as might their practice (as judged by programme implementation), or it might decrease, leading to a retreat from the programme. This study identified that when teachers with moderate teacher efficacy continually trialled activities (a potential source of cognitive and enactive mastery) and worked with colleagues (a potential source of verbal/social persuasion), their teacher efficacy and practice improved compared to teachers with the same level of teacher efficacy but who did not engage in the programme. Encouragement for this particular group of teachers, using the appropriate source of teacher efficacy, had benefits. Sources of teacher efficacy are further discussed below.

The third group of implications for professional development concerns programme strategies as potential sources of teacher efficacy. Bandura (1997) argued that to increase teacher efficacy, the sources of efficacy information must be utilized, rating mastery enactive experiences as the most important due to their authenticity of evidence. This study, echoing many other recent studies (for example, Tschannen-Moran and Woolfolk Hoy (2007), Brand and Wilkins (2007) and Bruce and Ross (2008)), found that rather than there being one source of teacher efficacy, an accumulation of many sources had the largest influence. Furthermore, a number of sources situated across contexts – both in sessions and in school – were important. The study's findings support Palmer's (2011) claim that enactive mastery (that is the action of teaching) is not enough for efficacy change, with cognitive mastery (that is understanding pedagogical concepts) ultimately required. Hence professional development providers might benefit from considering how theory, alongside practice, is planned into a programme, with the knowledge that (in this study) strategies such as simulated modelling by 'authentic' sources had greater influence than, for example, 'reading-activities'.

A further implication related to sources of teacher efficacy concerns social persuasion – or the role of colleagues. This research suggests that programme developers as well as school professional development organisers might benefit from being mindful of the importance that departmental collegiality, especially pairs of colleagues working together, has on successful programme outcomes. In particular, in this study, clear benefits emerged when pairs of teachers worked as bridges between programme sessions and schools, offering sources of motivation and verbal/social persuasion. Building on Bruce and Ross' (2008) findings concerning collegiality this thesis identified colleague characteristics which offered fertile conditions for professional growth as: collegiality prior to the programme; a participant having a post of responsibility within the department; and, a participant having prior knowledge of the programme's pedagogical framework. Schools might consider sending pairs of teachers to the same professional development programmes.

The final group of implications incorporates general issues from across the professional development field. First, this study's findings concur with earlier claims that for professional development interventions to influence pedagogical practice, programmes must run for an extended period (for example, Joyce and Weil, 1986; Fullan and Stiegelbauer, 1991; Yoon *et al.,* 2007). However, extending Tschannen-Moran and Woolfolk Hoy's (2007) research, which noted differences between experienced and novice teachers' reactions to efficacy sources, it is postulated that a reason for extended programmes is that teachers' efficacy takes time to develop and some teachers are unable to access particular strategies (or sources of efficacy) immediately. Extended programmes allow for efficacy and practice.

Furthering Guskey and Yoon's call for teacher development programmes to be 'well organised, carefully structured, purposefully directed, and focused on content, or pedagogy, or both' (2009:497), this study acknowledges the useful inclusion of tutor visits in professional development programmes. However, where previous research has stressed tutor visits as important in that they offer coaching (for example, Joyce and Showers, 1988; Adey, 2004), this study – where the role of visits was to jointly critique taught activities – found that tutor visits evoked teacher motivation to trial and reflect on new practices, hence triggering teachers to prioritise the activities which might not otherwise take place. Similarly, although under-reported in the literature, 'objects' such as reflective diaries and activity props were found to act as 'motivators' – reminding or triggering action in some teachers. So whilst both tutors' visits and props may have an additional cost, professional development providers might find these beneficial to enhance programme outcomes.

9.3.1.2 Implications for science teachers' outdoor professional development

Three implications emerged for organisers of professional development focused specifically on science teachers' outdoor pedagogy. The first relates to the influence of subject disciplines – biology, chemistry and physics. That is, where teacher efficacy is moderate or moderate-low, an individual's subject specialism may dominate activity choice, resulting in the science taught outside being restricted to, for example, biology for biologists and physics for physicists. This finding might imply that professional development providers need to ensure subject knowledge for activities, alongside pedagogical content knowledge, is provided for outdoor activities.

The second implication similarly relates to subject disciplines. That is, non-biologists might believe outdoor science equates to biology fieldwork. In this study, this misguided belief resulted in reduced teacher efficacy for a teacher with a chemistry background until she realised her biology colleagues had no better ability to teach outside than she had. Professional development providers need to be clear from the outset how outdoor science programmes, if at all, relate to biology/ecology fieldwork.

The third implication for providers of outdoor science programmes concerns the management of student learning outside. This study found that all teachers had some apprehension in this area which future programmes might wish to address directly. The findings suggest that teachers benefit from practical ideas which are immediately transferable to their practice, for example, where best to stand, and how to distribute equipment. These suggestions are better received when participant teachers give presentations or share activity ideas, as they are considered an authentic source especially when the school's context is similar. Finally teachers, especially those with beliefs aligned to social constructivist teaching approaches, might benefit from discussions of how student group work not only facilitates learning, but also can provide a strategy for managing students outside.

9.3.2 Implications and recommendations for theory

9.3.2.1 Implications for qualitative teacher efficacy methods

Klassen *et al.* (2011) notes that there are few qualitative teacher efficacy research studies. For the field to advance, Wheatley (2005) asserted, both qualitative and quantitative data collection methods need developing. This research study has gone some way to responding by developing a qualitative analytical framework where currently there are very few analytical tools available (for example, Brand and Wilkins' (2007) guide to self-efficacy sources).

Following an analysis of the research literature, a framework was constructed identifying traits of teachers with high and low teacher efficacy (Table 5-4). The five identified traits were: subject knowledge, flexibility, teacher/learner focus, behaviour and disposition. General polarised descriptions were given for each trait providing a framework that can be applied and adapted in other contexts. However, as Bandura (1997) proposed, specificity of task is fundamental to teacher efficacy judgement, hence descriptions reflecting possible teachers' reaction to the 'Thinking Beyond the Classroom' programme were given.

It might be inferred from the preceding section that the framework offers a direct analytical tool for teacher efficacy. However, teacher efficacy is a personal judgement requiring explicit statements concerning future tasks. Rather, the framework is proposed as the Researcher's Perception of Teacher Efficacy (RPTE), offering a method to examine participants' teacher efficacy in the light of observed behaviour and indirect comments related to teacher efficacy. For the majority of case study teachers, teacher efficacy and RPTE were similar. When differences were noted, the validity of teachers' self-evaluations were questioned. On initial appraisal this move may appear somewhat controversial, however data from several sources was used to support any differences noted (for example, lesson observations and in direct interview responses). The framework enables a method to substantiate teacher efficacy claims, and prompt further analysis where variation arises. High and low teacher efficacy descriptions are given (Table 5-4) enabling the identification of teachers in-between. The RPTE tool offers other researchers a possible method whereby indirect inferences can be made concerning teacher efficacy.

9.3.2.2 Implications for theories of professional development

By using teacher efficacy, derived from Bandura's social psychological theory of self-efficacy, this thesis adds to the professional development models discussed in Chapter 2 (for example, Bell and Gilbert, 1996; Adey, 2004). By considering the theory of teacher efficacy to explain both teachers' reactions to professional development and the related strategies/factors outcomes, an approach is offered not previously used in earlier professional development models (see Chapter 2). For example, Bell and Gilbert's model ('personal development' domain) proposed that prior to pedagogical change, teachers needed to acknowledge a problem and feel dissatisfied. Using the theory of teacher efficacy, feeling dissatisfied might be considered as 'pedagogical discontentment' – a state that teachers with high efficacy are more likely to possess and react to. Hence the behaviour Bell and Gilbert's model describes is rooted in a theoretical explanation.

The analytical framework for the categorisation of successful programme strategies/factors as potential sources of teacher efficacy offers an explanation of Adey's professional development model. For example, when Adey (2004) describes an effective professional development strategy as 'teacher ownership' (Figure 2) the framework can be used to identify the potential sources of teacher efficacy offered. In this case, potential sources for teacher efficacy are cognitive mastery (see Appendix 26 for a table of teacher efficacy sources and strategies). Hence, the teacher efficacy theory offers a rationale as to why professional development strategies are effective.

Finally to beliefs, both Adey's model and Bell and Gilbert's model acknowledge that beliefs have a role in teachers' development. However, where Adey's model emphasised that successful professional development was built on a 'theory base' informed by the beliefs of the innovation creators, Bell and Gilbert acknowledged the importance of teachers' beliefs in the interpretation, and the eventual success, of professional development programmes. Hence, this thesis forms a bridge between the two models in that the findings support both aspects proposed for the role of beliefs – from the perspective of the teacher and the professional development innovator.

9.3.2.3 Implications for the theory of science teachers' outdoor pedagogical practice

There has been little research exclusively focused on science teachers' outdoor pedagogical practice from a social psychological perspective. However, previous research has identified self-efficacy and beliefs as being influential on teachers' practice. That is, confidence/teacher efficacy has been postulated to limit teaching outside (for example, O'Donnell *et al.*, (2006) and Ofsted, 2004; 2008) and teachers' beliefs have been acknowledged, more generally, as influential on pedagogical decisions (Gregoire, 2003). Hence this thesis, by incorporating both belief system components and developing analytical frameworks has offered a theoretical understanding of secondary science teachers' pedagogical practice outside. Consequently, two implications for theory concerning science teachers teaching outside have emerged.

First, the majority of case study teachers were identified as possessing a belief that managing students outside would be more challenging than managing them in the classroom. It was suggested that this belief undermined the majority of the teachers' efficacy and influenced pedagogical practice. This thesis, using Foucault's (1977) and Bernstein's (1990) theories, proposed a theoretical explanation for these beliefs and the resulting pedagogical decisions. That is, Foucault's proposal that 'discipline proceeds from the distribution of individuals in a space' (1977:141), offers an explanation as to why uncertainty follows when a context is new and lacking routines and rules.

Conversely, once routines and rules are established in the new context, teacher efficacy generally increases. Due to these beliefs about behaviour management, the initial pedagogical practice default position, for the majority of case study teachers, was to adopt traditional teaching approaches. Bernstein's (1990) theory concerning Regulative and Instructional Discourse was used to explain this 'choice' in approach. That is, Regulative Discourse (RD) – new rules and procedures – was made explicit when the learning context was unknown. It was postulated that there is commonality between Regulative Discourse and traditional teaching approaches offering an explanation as to why such approaches were initially identified. Explanations informed by these two theories enable an additional perspective on, and a potential understanding of, participants' teacher efficacy and their behaviours. In addition, it offers an explanation as to why initial classroom and outdoor teaching practices are different, and why over time they change.

The second implication for theory concerning science teachers' outdoor pedagogical practice concerns subject affiliation with outdoor teaching. That is, in a limited number of case studies, a belief was evident that biology specialists were more able to teach outside than teachers of other sciences. This belief appeared to affect teacher efficacy and its influence remained until teachers found their practice had improved or realised that their belief was misplaced – biology teachers were not necessarily more skilled at teaching outside. This finding adds to the literature questioning the validity of science teacher discipline groupings (for example, Benson, 1989). Furthermore, it offers new insight into the potential influence that science teachers' subject identities – and the associated falsehoods – might have on pedagogical practice outside.

9.4 Limitations

While this study provides potentially valuable insights into the complexities of teacher efficacy, beliefs and pedagogical practice, several limitations are evident, encouraging caution in the interpretation of the findings, whilst offering possible avenues for further research (see Section 9.5). Examined below are two themes of limitations felt most important to the research findings.

9.4.1 The research participants

The data sets on which the findings are based are small. Six teachers were discussed in depth – and for two, observation data during Year 2 was not available. However, rather than being representative of all science teachers, this study presents findings for teachers who engaged in outdoor science professional development over an extended period. Of the teachers studied, there is nothing to suggest that they were either atypical or exceptional. Rather, all the case study teachers reported 'normal' constraints on practice – similar to those reported in the literature and as recognised from my own professional experience (for example, student management and time constraints). For the two teachers – Cara and Tom – where Year 2 observations were not available, interview data provided evidence that they did not teach the activities, hence allowing for the inference that pedagogical practice would remain unchanged.

Whereas all case study teachers received lesson observations during Year 1, only three of the six teachers were offered extended case study descriptions. Member checks, that is an attempt to gain a fuller understanding of the situation from multiple viewpoints (Lincoln and Guba, 1985; Smith, 1996), were only sought from Charlie, Claire and Megan, as it was felt the other case studies might perceive the descriptions as criticism – an outcome best avoided. This decision resulted in a lack of feedback from the teachers categorised as *less successful*. However, feedback from teachers with relatively 'positive' case study descriptions, suggests that the case study interpretation was shared, which tentatively might imply that this would be the same for the other case studies.

In Chapter 2, the professional development research literature illustrated how teacher change is influenced by factors at multiple levels – micro, meso and macro. Stimulated by the interest in teacher confidence in teaching outdoors, the study's focus targeted the micro-level. Hence, in responding to RQ2 - What professional development strategies are significant in influencing teachers' practice?, whilst occasionally noting external factors such as the influence of colleagues, the discussion generally focused on the teachers' internal response to an experience or object.

Hagiwara *et al.* (2011) acknowledged in a recent paper that the majority of studies concerning teacher efficacy are limited due to the lack of knowledge of the context's collective efficacy. The authors note, however, the 'immense complexity' in collecting data to attempt to understand the multiple social dynamics, including student attitudes, beliefs, self-efficacy and behaviours of the headteacher, sense of school community and decision-making. Hence, although some attempt was made for Cara and Charlie, what were omitted from this analysis were in-depth students' and school efficacy levels (collective efficacy) and the influence they might have had on the case study teachers' responses to the professional development intervention. For example, students' self-efficacy for learning science and practical science outdoors will influence their response to the intervention activities. Mediated by teachers' efficacy, students' responses, and specifically the learning benefits observed, would influence the teachers' assessment of the programme and their role within it. A further example is school efficacy levels, for example, senior staff teams' judgement of students' and teachers' ability to achieve effective learning would influence student and teachers' efficacy. Hence, although a potential 'next' step to a deeper understanding of how 'factors' of professional development can influence practice, the resources needed – for example to interview students, headteachers, analyse student data and school documentation – would have meant involving fewer case study schools, potentially compromising the findings from the study's cross-case analysis. With limited literature concerning teacher efficacy related to professional development and the outdoors, a broader view to enable a greater understanding of the field was considered appropriate. However, the descriptions presented of the school contexts and teachers' thoughts concerning professional development in the school offer an initial insight into the influence of schools' collective efficacy on practice.

9.4.2 Researcher's role

Two limitations concerning the researcher's role emerged. First, in Chapters 4 and 5, the duality of my role as researcher and programme tutor was discussed, as were the preventative measures taken to ensure impartiality whilst collecting data. However, due also to previous professional relationships (see Table 5-1 and Chapter 6) with several case study teachers, on reviewing the interviews, on two occasions a role as tutor/mentor (rather than strictly researcher) was identified. On one occasion the interview became a teaching tool. That is, during an interview (July 2008) with Michael, when questioned about 'cognitive conflict', he eventually replied he was unsure what the concept was and asked for an explanation. The next four minutes of the interview were spent discussing the concept which could have led to me potentially acting as a source of verbal persuasion.

The second occasion when the research interview acted as a teaching/reflection tool, was when Charlie was prompted to reconsider aspects of the professional development to trial. This point is illustrated below in his response to whether his questioning technique changed outside compared to the classroom:

Charlie: When I was questioning them [inside] about the presentations they were giving, I was trying to bring in all the other [students'] group's tasks - what they thought about. That questioning I had planned.
I: Okay. But when you were going around the groups outside you hadn't quite thought of the prompt questions that you were going to ask?
C: No
I: No…
C: I may have been using them as I had them at the back of my mind. I must have been, yep.
I: Okay…
C: I must have been asking them: what they were, what they were looking for, why they thought that was important, and how they would demonstrate what they were looking at was a habitat and whether it was a good one or not. I guess I was using the same questions… hey.
I: Hey, okay…
C: I just hadn't really thought about it (laughs)
I: Yeah, okay, I think it is quite useful to sometimes think about the questions in different contexts. They actually are probably quite useful questions that you are asking, but you just haven't got the sheets [with the questions written on] with you.
C: Yeah.
(Charlie, Interview, March 2009)

Charlie was prompted to think about his questioning when teaching in a different context. However, due to the duality of my role, it appears the research interview questions such as: *What skills/areas do you plan to further develop through the next activity you teach?* (See Appendix 10 for interview questions) not only enable insights into teachers' beliefs and teacher efficacy, they also, understandably, generate reflection and pedagogical action. Although unplanned, these outcomes are not necessarily constraints. The questions asked by someone perceived as interested in their professional learning rather than their own research agenda might serve to elicit a more open and in-depth response.

The second related limitation concerns the analytical frameworks developed and used in this study. In Section 9.3.2.1 the potential implications of the RPTE analytical tool were presented. However on critiquing this tool, and the observation framework, it is acknowledged that from an interpretivist framework, even with, for example, explanatory descriptions for teachers with high teacher efficacy (see Table 5-4), some emic knowledge is required (Greene, 2010). As Lincoln (1990) suggests, interpretivist studies are value-bound and whilst descriptions such as 'low level of subject knowledge' and 'limited closed range of question' offer a level of transparency tacit knowledge is required. Whilst the study offers, 'rich descriptions' (Becker, 1970) with exemplar data to enable transferability (Cronbach, 1982), it is accepted that the ‘final judgement [about transferability] is rested in the person seeking to make the transfer’, such as the interested reader, other researchers or practitioners (Lincoln and Guba, 1985:217).

9.5 Future research

Focusing on professional development at a micro-level (individual teacher), this thesis acknowledges that a greater understanding is required of the influence of the meso and macro professional development levels on science teachers’ pedagogical decisions/practice. Research questions, arising from both the findings and the literature reviewed, are outlined below.

9.5.1 Research related to theory

What is the interplay between beliefs, teacher efficacy and pedagogical practice for teachers who have not completed a professional development programme? What factors influence their initial engagement and premature departure?

This study focused on teacher participants who were engaged, to differing extents, for the programme’s duration. However, from the original ten schools that started the programme, some teachers departed the programme prematurely. Most professional development programmes have attrition and an understanding how this group’s beliefs and teacher efficacy influence their initial decision to be involved and then depart might enable a programme to be developed that sustains involvement. From this study’s findings it might be postulated that teachers who left the programme had teaching approaches more in line with traditional beliefs about learning feeling uncomfortable with the professional development strategies. Perhaps this group of teachers might have had low or very low teacher efficacy to teach science outside. Or perhaps, something else was at play. However if identified, a programme might be developed and implemented that included strategies more conducive to this group’s needs.

What is the influence of science departments and school collective efficacy on the implementation of an outdoor professional development programme?

This study’s findings suggest that the role of colleagues was important to programme implementation. Furthermore, Ofsted (2008), in a report evaluating the impact of learning outside the classroom, highlighted that,

> […] the most effectively managed schools and colleges included learning outside the classroom as an integral part of a well planned curriculum which ensured the coherent and progressive development of knowledge, skills and understanding.
> (Ofsted, 2008; 4-5)

Research, therefore, concerning beliefs and collective efficacy might enable a greater understanding as to why some departments and school systems encourage or facilitate working outside whilst others do not. For example, do members of science departments or senior staff teams articulate particular beliefs concerning student learning that influence teachers' decisions to use the outdoors? What is the collective efficacy of the school concerning student success – and what is considered as success? Furthermore, as noted in the literature (see Section 2.3.2.1), research is required to understand the role student efficacy and beliefs has on teachers' pedagogical decisions especially in terms of teaching outside. Finally, the relationships between student, teacher and whole school efficacy towards learning and learning outside, are important to understand before a cultural shift in secondary science can occur.

What are the beliefs regarding learning science outside of CEOs/Chairs of institutions engaged in influencing science education policy and funding interventions programmes?

The final research area relates to the macro-level of professional development. In Section 2.3.3.2, a number of institutions were listed as having influence on science education policy – including outdoor science and professional development. Researching the beliefs of institutions' policy makers and CEOs concerning outdoor science and professional development might offer a new perspective on the current practice observed in schools. That is to say, how similar are institutional beliefs and science teachers' beliefs concerning, for example, the aims of science education, how they might be best achieved, and what is the status of the outdoors compared to the science laboratory? Are some groups of science teachers' beliefs more in tune with particular institutions? If more were understood about the potential influence of institutions on informing teachers' beliefs, and visa versa, research might be disseminated more strategically to influence pedagogical practice.

9.5.2 Developing further tools for analysis

How might the RPTE analytical framework be adapted for use within other research contexts?

Further research is required to refine, adjust, adapt and further validate the RPTE analytical tool so that it can be used within other contexts. Terms used within the framework might need to be developed so that they are more generic and transferable to other settings. More details of traits for very high, very low and moderate teacher efficacy might be required to allow for greater transferability. Using the tool across a number of different research contexts should enable agreed terms to be developed and tested. Finally, the STEBI, to some extent, was used as a qualitative tool, rather than a quantitative tool. Further development of this tool so that it might be used to substantiate observations or interview findings would be worthwhile.

9.6 Final word

The questions outlined above present challenges for future research. Returning, however, to the aim of this study – to explore the relationship between a two-year professional development programme and participating secondary science teachers' beliefs and teacher efficacy – the six case studies provided evidence that the teachers with social constructivist teaching approaches and high teacher efficacy were more responsive to an outdoor science professional development programme than the teachers with beliefs more aligned with traditional teaching approaches and moderate-low teacher efficacy. It is recommended that outdoor teacher development programme providers be clear in their pedagogical framework and share it with participants. Providers might consider the use of suitable strategies to engage teachers with a broad spectrum of beliefs concerning learning. The findings of this thesis suggest that developing programmes to include a range of teacher efficacy sources, with particular emphasis on providing access to cognitive mastery experiences, may increase teacher efficacy.

At the centre of this thesis is the belief that students not only learn science outside but they also learn why science is important to their everyday lives. The Manifesto for Learning Outside the Classroom (DfES, 2006) offered an opportunity for educational change – providing a vision. However its enactment resides in our science teachers, their beliefs, their aspirations for their students, and their confidence in their practice. This study provides further insights into teachers' beliefs and teacher efficacy concerning the outdoors so that, with time and research-informed professional development, the aspiration for increased outdoor science learning might become a reality.

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Appendix 1 Research supporting learning outside the classroom

Educational benefit (Rickinson *et al.* 2004)	Examples of learning outside the classroom
Cognitive	Authentic and first hand opportunities to construct, test and refine new concepts across a range of challenging experiences leading to a more solid understanding (Driver, 1989; Lock, 1998). Science concepts can be observed holistically, rather than in the discrete traditional boundaries of biology, chemistry and physics, enabling a wider understanding (Braund and Reiss, 2006). Experiments conducted and data collected in real-life settings offers an insight into the 'messiness' of science, challenging myths about science propagated by the standardised experiments of school laboratories (Hodson, 1998). Handling organisms or objects within the habitat can offer new skills of observation and categorisation (Leinhardt and Crowley, 2002). Experiences gained outside, compared to inside the classroom, promote long-term learning (Mackenzie and White, 1982; Nundy, 1999).
Affective	Can engender increased levels of enjoyment acting to motive learning (Cerini *et al.,* 2003; Fägerstam and Blom, 2013). Often memorable experiences are formed supporting long-term knowledge recall (Mackenzie and White, 1982; Piscitelli and Anderson, 2001; Fägerstam and Blom, 2013). Offers students an increased appreciation of the contexts scientists might work in – potentially increasing attitudes towards science (Braund and Reiss, 2006).
Social/interpersonal	Offers opportunities for students to work independently; students' self-esteem, self-confidence and general levels of trust in others rise significantly (Amos and Reiss, 2006). Teamwork skills develop and new relationships are built - being maintained back in the classroom (Amos and Reiss, 2012; Dillon *et al.,* 2005; Nundy, 1999). School-based outdoor learning in school grounds has a positive effect on student participation and social behavior (Fägerstam and Blom, 2013)
Physical/behavioural	As senses are alert to new experiences motivation increases (Falk, 1983). Behaviour is better, or as good as, that in the classroom (Amos and

	Reiss, 2012). Environmental values and behaviours can be fostered more readily through direct contact (Amos and Reiss, 2012; Bogner, 1998).

Appendix 2 Examples of 'Thinking Beyond the Classroom' activities

Examples of activities are:

a) Air pollution
b) Forces all around us
c) Our School: Urban Jungle
d) Seeing the world through rose tinted glasses
e) Egg box

	Air Pollution
Science context Air pollution Human activity can lead to changes in the environment **HSW** Making observations and inferences, evaluating scientific evidence and working methods **Mathematics** Geometry and measures: construction, loci and bearings **Where?** In and around the school grounds **Time** This activity can take up to three lessons: the first focuses on planning, the second focuses on collecting and presenting data, and the third focuses	**Lesson summary** In this activity, students will consider methods to measure air pollution*. They will investigate the range of air pollution levels within their school grounds. They will decide on the best place to locate an open-air café, within the grounds, using data collected to support their decision. **Cognitive potential** This activity gives students the opportunity to identify an appropriate approach to data collection and to critically analyse and evaluate evidence from their observations and experiments. **Central theme and skills** Air pollution Making observations and inferences, evaluating scientific evidence and working methods **Key resources** Clipboard Long tape measure/ trundle wheel Sticky tape White paper Sample leaves (from outside) Hand lenses Poster paper Pens and pencils Optional: Sound datalogger Tree identification key Microscope slides Digital camera Graph paper photocopied onto acetate

on analysis of evidence and evaluation of methods.	
	Setting the scene (15mins) In class, show the YouTube Clip: http://www.youtube.com/watch?v=UcWpkWBX04E After presenting them with this, ask the class to discuss in their groups the following questions: **Why do we hear about air pollution in the news? What do you think are the key sources of air pollution in our town/ city? How does air pollution affect the environment and us?** The website: http://www.londonair.org.uk can also be used to present regional and local air pollution data sets. Explain to the class that one of the air pollutants, particulate carbon, deposits on surfaces and this is what makes the surfaces dirty. Model, how clear sticky tape stuck on a leaf/ bark/ wall and then carefully removed is one way of observing and collecting evidence of the particulate carbon deposits. Give each group a leaf and some clear sticky tape to try it out and ask them to think about how this method could help them to investigate the following problem: **You have to decide where would be the best location for a new open-air café in (**whatever local park/square you decide to use-show them a photo of this site). **It is hoped that all the community- children, mothers, babies and the elderly- will be able to enjoy the outdoor seating. The local authority has become increasingly concerned about the health risks associated with air pollution. Your job is to locate the café in an area where the levels of air pollution are low.** **How will you go about your investigation?**

	Ask different groups to share their ideas with the class. Challenge them to consider how a range of sites and sampling might make their investigation more reliable by asking them and the class questions around this: **What evidence will you collect? What will this tell you? Where will you collect it? How much evidence do you think you need to collect to convince the local authority that this is a good place to locate a cafe?** **How will you present your data?** After the whole class discussion, give the groups some time to write out and refine their plans in class so that they are ready when they go out to the local park in the next session. ***Observations outside (15-30mins)*** Take the class to the local area. Have a brief whole class discussion before sending them off to check that they have the resources they need, are clear about what they are going to do and what data they are going to collect. This includes locating sites on a map, labelling and numbering their data and collecting any other data (what they notice about the sites- traffic, parked cars, types of transport, sunny spots, areas that the community seem to enjoy using) that might be of use. Ask questions to help them recall and plan effective strategies for collaborative group work. Give the groups 15-20 mins to collect their data. During this time, move around the different groups, observing and listening to them. At one or two points in this time slot, stop and bring them back as a whole class to share ideas, findings, other observations that you think might be of interest to the whole class. If possible, take some digital photographs of the local park, the different sites and the groups at work. ***Sharing ideas and provoking conflict (30- 45 minutes)*** Back in class give the groups some time to gather their data, make up graphs and prepare it for a presentation - you may want them to do this as a poster, on PowerPoint, or even as a small set of handouts that can be photocopied and presented to the rest of the class in the presentation session. Support them through this with some questions that encourage them to analyse their graphs and use this evidence to draw conclusions. These questions could be up on the IWB or on a prompt sheet: **Describe what your graphs show about the distribution of solid particulates within the different sites.** **Imagine you are explaining your results to a Year 7 pupil.** **Explain why they show the trends they do. What reasons can you give for this pattern in the data?** **Using your evidence, explain where you think the best place to locate an open-air café would be and why.**

	Their presentations need to be completed by the end of the session or as part of homework so that they are ready to present these in session 3. ***Linking ideas together (30- 45mins)*** Select several groups to present their investigations. This could be completed outside at the different sites each group has chosen. Each time a group presents, the rest of the class acts as the local authority. Explain to the class that, as the local authority, their job is to: - make sure that they understand how the presenters carried out the investigation (**Did they explain what they did clearly?)** - check they did a thorough job (**Are you satisfied with how they went about their investigation?)** - assess whether they think the evidence is convincing and reliable enough to make a decision upon (**Is their evidence reliable?)** After each presentation, invite the students (local authority) to ask the presenters questions related to the ideas above. You could then ask the class to work in pairs to score (out of 5) each presentation under the headings above. Then give the class about 10-15 minutes to go back into their groups to evaluate their own investigations. Again give them some prompt questions to help them record their ideas: **In your experiment how have you attempted to make it as reliable as possible?** **What were the main difficulties you found when collecting the results?** **What information do you feel is missing to gain a better understanding of the amount of pollution in this area; and how might we collect this data?** **If you could do the investigation again, what would you do differently? How would this strengthen your evidence?** ***Extension/homework/individual task*** Having discussed their ideas and recorded their thoughts as a group, you might want to use these questions above as a worksheet so that students can record their individual responses to these. *****'Air pollution is made up of a mixture of gases and particles that have been released into the atmosphere by man-made processes. Such emissions are typically from the combustion of fossil fuels such as coal, oil, petrol or diesel. The sources, health effects and chemical behaviour of each separate pollutant are different, making the task of understanding and controlling air pollution as a whole very complex. There are seven main pollutants of concern - carbon monoxide (CO), nitrogen dioxide (NO_2), ground level ozone (O_3), particulate matter (PM10 and PM2.5, sulphur dioxide (SO_2), hydrocarbons and lead).' (http://www.londonair.org.uk)

Mathematical plug-ins

1) Take a map of the region. Look for potential sources of pollution e.g. a road (straight lines), a factory (point), airports (point). By drawing appropriate lines, curves, angle bisectors on the map, find the optimum position for lack of pollution. The radius of the circles may change depending on how extreme the source of pollution is.

2) The gardening project:

Background:

You have been asked to design a garden for your new neighbours because they know you have the design skills and scientific knowledge to grow them a prize winning garden. You must first draw a scale drawing of the plot to include the key features that are already in the garden and those they want added. You must then decide what to plant in the flower beds based on a variety of scientific facts about the plot.

Task 1: Scale Drawing

Draw an accurate drawing of the garden described below. Use squared paper and use one square for 20cm. Remember 1m=100cm. Use a key for the colours and patterns you use and mark on the compass directions.

Garden description

House: 5m wide, south facing

Garden: 5m wide (like the house), 4m long.

All sides that are not the house are fenced.

Greenhouse: In the far left corner of the garden.

It is 80cm wide and 160cm long.

It touches the back fence and is 40cm from the left fence.

Pond: The pond is a circle of radius 60cm. The centre of the pond is 2.5m from the left fence and 80cm from the back fence. It has a shingle path of 20cm around the edge of the whole pond.

Tree: Planted 40cm from the back fence and the right fence. The top is large, covering a radius of 120cm.

Patio: The patio is 3m wide and 120cm deep. It touches the house and the right hand Fence. It has a 40cm step around the whole patio to step down into the garden.

Flower beds: Wherever there is no shed, pond or patio, there is a flower bed of 80cm surrounding the garden.

Task 2: What to plant

Your neighbours want to fill their garden (and greenhouse) with plants. They want to plant in every patch of flowerbed. To do this you must find suitable plants for each part of the garden.

Write a list of factors affecting where a plant will grow best. Think about environmental factors and human factors of influence. If you are near a garden or potential garden site, go and have a look for inspiration. **What plants are growing where?**

Look at your garden. What factors in particular do you need to consider when building your garden?

Split your flowerbeds into several (about 6) sections depending on what the environment is like (e.g. Area 1 might be under the tree because it is shady, sheltered and the tree will take lots of the water).

Write your areas into the table below using a short description e.g. Under tree

Look through the plants database provided.

Fill in the table below:

Area	Plant	Reason

Discuss with the other groups what plants they put where and why. Can you see any potential problems with any of the other garden designs? Was there any information you would have liked to help you design a better garden?

This websites will aid this activity:

http://www.gardeninghelpuk.com/plants_for_places.htm
http://www.bbc.co.uk/gardening/design/virtualgarden_index.shtml
http://www.flightglobal.com/airspace/photos/response/images/23851/sikorsky-76-over-london-eye.jpg

Forces all around us

Science context

Forces

Forces acting upon an object can make it move, increase speed and make it stop. For example, a flower blowing in the wind displays numerous forces acting upon it.

HSW

Using scientific ideas and models to explain phenomena.

Critically analysing and evaluating evidence from observations.

Mathematics

Transformations;

Identify and classify patterns

Where?

In and around the school grounds

Time

70-85 mins

Lesson summary

In this activity, students will show and develop their understanding of balanced and unbalanced forces by looking for, and recording, examples of forces in action within their school playground.

Cognitive potential

Forces have size and direction. They can push and pull. They can make things move, change direction, change speed and stop. Everywhere around us, there is evidence of forces in actions. The challenge for many students is that some of this evidence seems invisible (i.e. a stationary object). In the classroom, the concept of forces is often introduced using pictures and diagrams. This activity enables students to apply these classroom experiences to the real world around them and focuses on encouraging students to begin to see the relevance of school science within the context of their more complex, everyday environment.

Central theme and skills

Forces

Making observations and applying scientific understanding

Key resources

Each group will need a copy of the photograph of the bench in the playground and a ‘forces’ pack that includes:

- Key words: e.g. gravity, reaction force, air resistance, friction, balanced, unbalanced
- Arrows: a number that vary in length to encourage students to think about the direction and size of forces.
- Blank cards and a pen

Digital camera

Blu-tac

Note books and pencils

Setting the scene (5mins)

Divide the class up into their newly established groups of threes or fours. **Think back to the last time you worked as a group. What worked well? What didn’t? What kinds of things do you need to do to work well together, as a team? How is working outside the classroom different?** Give the class some ‘thinking time’ to reflect on this individually and then get them to share their thoughts with each other, either in their group or in pairs. Use their ideas as a basis for re-establishing some common ground rules for group

	work and working outside the classroom. ***(10-15mins)*** Give each group the photograph of the bench in playground and their pack of words and arrows**. Decided as a group what you need from the pack to help explain all the forces that you think are present in this photograph. Think about where you would place the words and arrows. You will need to give reasons for your decisions.** Give the groups about five minutes to work on this before gathering them back as a whole class. Have the photograph up on the IWB. Invite different students to come up and talk about and demonstrate one word or arrow that their group decided to use**.** At the end of this discussion ask them: **Are the forces in this example balanced or unbalanced? Why?** (This activity could be completed outside). ***Observations outside (10mins)*** Give each group some paper and one pen. Ask the students to explore, in their groups, the playground and look for and record up to five examples of something they all agree shows forces in action in the playground. **You need to find at least one example of unbalanced forces and one of balanced forces.** Encourage them to make annotated sketches as they will be referring back to these later. ***Sharing ideas and provoking conflict I (15-20mins)*** Collect groups back to a central space in the playground and give each group the forces pack that they were using back in the classroom. The groups now need to decide on two of their earlier identified examples that they could go back to; one example of balanced forces and another of unbalanced forces. Their challenge is to think about which words and arrows in their pack could be applied to their chosen example. **Remember what we did back in the classroom? I want you now to do the same thing. Decide as a group what you would need from the pack to help explain all the forces that you think are present.** Send the groups off to go to their examples and give them about 10 minutes to work on this, using Blu-tac to attach words and arrows to show the forces in action in their example. They may use their own bodies to stick words/arrows on to illustrate invisible forces. E.g. if the students want to label the forces acting on a bush, one student could stand alongside the bush and words and arrows could be positioned on them corresponding to the position on the bush. If possible, try and get some digital photographs of these examples for possible later classroom work. ***Sharing ideas and provoking conflict II (15mins)*** Collect the groups back and either pair up groups so that they can show and

	explain their examples to each other or keep them as a whole group and move to a few selected examples, getting particular groups to present their ideas and the others to evaluate. **Is this the only way? What else would you suggest? Why?** ***Linking ideas together (15-20mins)*** Gather the whole class back to reflect on the learning. They could think about these questions individually, in pairs or in their groups before a whole class discussion. You can also ask them to write down their responses to these questions. **As a group, what did you talk about that helped you to decide that something you could see around you was an example of forces in action?** **What were some of the problems with using the pack to explain your examples?** ***Extension*** **How many different examples of forces can you spot around you on your journey between home and school?** ***Mathematical plug-ins:*** **"Transformations" all around us** This should work in a similar way to forces all around us with a couple of substitutions: In the pack: Key words: Rotation, Reflection, Translation, Enlargement Provide a picture of the London Skyline with the same one on the IWB. Ask pupils to find as many examples as possible in the picture of transformations (e.g. Reflection: The river, shiny glass, rotation: the London Eye, wheels in general, the hands of Big Ben, translation: a boat along the river, going up in a lift, pacing a capsule of the London Eye, Enlargement: the photo in itself) **How did you know it was a transformation? Does everybody agree? What defines each transformation?** (mirror line, centre of rotation, direction and angle of rotation, centre of enlargement and scale factor, a vector for translation) Provide students with: A metre stick, a large protractor, red tape (mark mirror lines and centre of rotations) Ask them to find examples of each of the four transformations in the school grounds and also an example of a composite transformation. Take a photo of each example suitably labelled with tape, and take the necessary measurements to draw the example on paper. See sharing ideas and linking ideas together in the "forces all around us" activity to complete this lesson.

Science context	# Our School: The Urban Jungle
Science context Food chains Organisms need a range of living and non-living resources to survive. **HSW** Obtain, record and analyse data from a wide range of sources. Contribute to presentations and discussions. **Mathematics** None **Where?** In and around the school grounds **Time** Two x 45min-60 min	**Lesson summary** This activity will encourage students to consider local habitats and evidence necessary to support their claims. **Cognitive potential** In this activity, students are challenged to define a habitat and consider local sites which normally are ignored. They will investigate their school, locating unusual habitats and decide on appropriate data to collect (photographs, diagrams, sketches, living things, written descriptions) as evidence to support the claim that it is a habitat*. **Central theme and skills** Organisms need a range of resources to survive. Resources are not always obvious. Evidence to support claims can be collected using different methods. **Key resources** Each group will need a set of 4-6 photographs for the class discussion on habitats. Try and include examples that will create a conflict of ideas as well as more obvious habitats that students will typically find in their local area and in and around their school. Your set could include photographs of: • Cracks in the pavement where there is evidence of plant life that could be supporting insects and other small invertebrates. • Paving, walls that have lichen. • Buildings and structures where pigeons might stop • A pond • A river • A puddle • Sports/playing field • Dead/rotting wood • A brick • A rock For the main activity, each group will need a kit of resources that they can use to help them collect their evidence. This could include: • Pooters and pack of drinking straws • Magnifying glasses and specimen pots • White tray • Spoons and very fine paintbrushes or pipettes to scoop up some living evidence to put in the white tray • Plain paper, graph paper and lined paper

	• Pencils • Digital camera • Identification keys • Poster paper and pens •
	Setting the scene (20mins) In class give each group of students the set of photographs and explain the task. **In your pack some of the places are habitats and some are not. In your group, you need to decide on those that you think are habitats, which are not and give reasons for your choices.** Give the groups 5-10 minutes to discuss this. Move around and encourage them to explain and justify their decisions to each other. Pick up on any disagreements or any 'tricky' photographs that you can bring up in whole class discussion. Ask the groups to make a note of their decisions so that you can refer to this at end of the session when you ask them to reflect on whether their thinking has changed/moved on. Bring the class together and invite different students to share what was discussed in their groups: **How did you decide if somewhere was a habitat?** **Were there any that you were not sure about? Which one? What made it tricky to sort?** **Did you have any disagreements?** Use this to develop a shared understanding about habitats. **What are similar about all the places that we think might be habitats? What is different?** Then share a few photographs of places in and around the school. **Do you think there are any habitats in our school? What would you look for,**

what kinds of data would you collect, to be certain that it is a habitat?

Generate some whole class ideas for possible sources of data collection and write them down.

Observations outside (15-20mins)

In your groups, I want you to investigate a hidden habitat around our school. (You might want to identify some 'zones' or use Google Maps to help manage and circulate around the groups.)

You need to collect some evidence from this habitat to support your claim that it is a habitat. Each group will have a kit of resources to help with this data collection.

Give each group their kit in class.

As a group, you will need to make sure that in your collection of evidence you have:

- **2 sketches of your habitat- these need to be labelled**
- **A written description of your habitat**
- **A list of what you found in that habitat (living and non-living)**
- **A very small sample of some of the things that you found in the habitat**

How could you use what you have in your kit to help you collect this and other evidence? How will you organise yourselves as a group to meet this challenge?

Give the groups about 5 minutes to talk about this and ask some of them to share how they will manage roles and tasks within their groups. Use this as an opportunity to emphasise the need for delegation, negotiation and assigning roles when working as a group. Ask some students to recall what kinds of skills and attitudes help a group to work well.

You have 5 minutes to walk around the areas that we have agreed on. You need to find at least four sites that you think might be a habitat. Following this you need to come back to this agreed spot so that we can collect our ideas as a class.

Send the groups out without their kits for this initial site finding task. Agree on a spot where they will reconvene. When the groups are back, collect some of the ideas. You could write these down on a big piece of paper. Each group will now need to decide on one place where they will go to collect their evidence before setting off. Give the groups their kits.

Give the groups 15-20 minutes for this task. Use this time to move around the designated zones. Support the groups by asking them to explain what they are thinking, what they are doing and why they are doing it. Encourage them to describe the living things within their habitats and get them to start thinking about possible feeding relationships that might exist within their habitats. Also get them to evaluate their habitats:

	What kinds of life does your habitat support? **Is it a good habitat? Why? Where is the light? Green plants? Water? Food?** ***Sharing ideas and provoking conflict (15-20mins)*** Gather the groups back into the classroom. Give the groups about 20 minutes to prepare their presentation. This might be a poster that collates all their evidence already collected. Encourage the groups to annotate their diagrams, labelling parts etc and to use the keys provided to identify what they have found. Challenge the groups to think about relationships between the different living things in their habitat and to use food chains to describe these. **What kinds of life does your habitat support?** **Where is the light? Green plants? Water? Food?** **Is it a good habitat? Why?** Stop the class and prepare them for the presentation phase. You may want to use this brief discussion to establish an understanding of food chain, producer, predator and prey. **As the audience, what are you looking out for to be certain that the place is a habitat?** **What kinds of questions would you want to ask to find out more about the habitat?** Then select some groups to present their findings and invite students from the audience to probe the presenters and assess the evidence. ***Linking ideas together (15-20mins)*** Give the students about 10-15 minutes to reflect on their learning in their groups or pairs. **What was hard about collecting evidence? Is there any 'missing' data? What else would you do if you could go back to your habitat to collect more data?** **If you went back later, would your habitat still be the same? What the evidence change? Why?** **How reliable is your evidence?** Give the groups the same set of photographs used at the beginning. Encourage them to reflect on their learning. **Can you remember what you thought about these photographs at the start of the lesson? Has your thinking about habitats changed? Can you explain why?** *****A habitat can be defined as the natural environment of an organism. Several individuals of the same species living together in the same place at the same time

	are called a population (for example a population of woodlice living underneath a plant pot.). A community describes a collection of populations of different species interacting within a habitat (for example the woodlice, a population of slugs and the mosses all living together underneath the plant pot). A habitat can only support plants and animals that are adapted to its conditions and then only in limited numbers. This is due in part to the competition that exists between, and within species for limited resources such as food, space, oxygen and light. The organisms within the habitat have different feeding habits and occupy different trophic levels. The more obvious examples of habitats include grasslands, woodlands, rocky shore and rain forests, each having its own special set of animals and plants. A micro-habitat is a scaled down version of a habitat, with several microhabitats found within one habitat e.g. underneath a plant pot in a garden.

Science context	Seeing the world through rose-tinted glasses

Science context

Colour

The colour of an object depends on the wavelengths of light that are scattered and absorbed.

HSW

Contribute to discussion about scientific ideas

Mathematics

None

Where?

In and around the school grounds

Time

60 min

Seeing the world through rose-tinted glasses

Lesson summary

In this activity, students will identify what colours they see as they walk along a route in and outside the school. In pairs, at particular points, they will compare what colours they see with and without filter glasses. This will feed into a discussion to consider what they think the glasses do. This activity will help students to reveal what they understand about how we see colour and how coloured filters work in this process.

Cognitive potential

This activity will introduce students to the idea of light wavelengths and will elicit their prior knowledge. Through the discussions the students may encounter a variety of possible explanations and a feeling of uncertainty. Students will need to listen to alternative ideas from other groups to reconsider their original theories of how filter glasses work.

Central theme and skills

Energy (light)

Contribute to discussions about scientific ideas

Key resources

Class set of green filter and red filter glasses.

Purchased from: www.rainbowsymphonystore.com

A table to complete with the headings:

Point/object	Partner 1 With red (green) filter glasses	Partner 2 without	Partner 2 Return journey with red (green) filter glasses	Partner 1 Return journey without

Poster paper and pens

Setting the scene (5mins)

Introduce the pupils to a plan diagram of the map of the school grounds. Ask students to locate specific areas on the map to familiarise themselves. Tell

	students that they will need to annotate the map with the route they take later. Write a message on the board using green and red pens. Give out filtered glasses and reveal the message on the board. Tell students that they are going to consider what filters do to light and colour that effects how they are seen. ***Observations outside (15-20mins)*** Ask students, in pairs, to walk a specific short route that covers some inside school space (hall, gym and library) and some outside space (playground). In pairs, one partner will wear the red filter glasses. At each stop, the partner without the glasses, points to objects/pictures and asks the partner with glasses to describe the colours/ textures etc. they see. Then they tell their partner what colours they see without glasses. They record these descriptions in a table. On the return route, they swap over and go back to the same points/ objects and re-record the colours again. This activity then is repeated, this time with the green filter glasses. ***Sharing ideas and provoking conflict (15-20mins)*** Back in class get the pairs to regroup back into their thinking groups for small group discussion. **Talk to each other about what colours you saw with and without the glasses.** **What do you think these glasses do?** Then ask and collect ideas on **What's similar and what's different about seeing** **a. with red glasses and without** **b. with green glasses and without** **c. between red and green glasses** **Is it always true that people see things the same?** **Why might that be?** (You may not want to ask all these questions and focusing on one filter colour may be sufficient) Again ask **What do you think these glasses do?** Give the groups time to talk about this and ask them to take one point/feature that they recorded and use this as the basis of their annotated diagram to illustrate their thinking. ***Linking ideas together (15-20mins)*** Gather the groups together for a whole class discussion Invite different groups to share their illustrations. Encourage the listeners to consider the different ideas and compare/disagree/agree **What do you think about that idea? Who thinks something else?**

	What’s easy and what’s difficult to explain about the changes you saw? After this whole class discussion, ask the class to reflect and write down their thoughts individually, in their books. **Has your thinking changed? What do you think glasses do?**

Science context

Synoptic

HSW

Assessing risk, making observations and carry out group work

Mathematics

Geometry and measures

Where?

In and around the school grounds

Time

60 min

The Egg Box

Lesson summary

This activity focuses on developing group work and working in the outdoors with pupils for the first time. Pupils will be asked to find one object that they consider is a good example for each of the six categories.

Cognitive potential

This lesson is synoptic in nature, in that it incorporates a range of scientific topics, which can be used to review a pupil's general science knowledge and ability to link scientific principles together. As this lesson may be the first exposure that pupils have to working in science outdoors, the main objective is to encourage safe and effective use of the outdoors, which engages the pupils in active learning, encourages discussion and promotes group work and Cognitive Acceleration.

Central theme and skills

Synoptic activity – considering a range of science topics

Assess risk and work safely in the field; make observations; and carry out group practical work

Key resources

Egg box with numbered compartments (one per group)

Paper and pens

Setting the scene (10mins)

Divide the class into the newly established 'outdoor' groups of threes or fours. Ask the groups to write a list of rules for successful group work. Ask the groups to share some of their thoughts. If you record these on the board you will probably find that they can be split into two separate groups: rules for working safely (e.g. don't run, only go where you are allowed) and rules to support the best group work outcome (e.g. listen to one another, have a role). The first group of rules are important in that the pupils have highlighted themselves, and therefore have illustrated their knowledge of expectations outside. Probing individuals to explain how they might best achieve rules from their second list encourages pupils to consider group roles.

Give each group an egg box and the list of categories. Explain the group's task is to decide on the best example from outside to fit each category. With the activity in mind, ask pupils to reflect again on their rules for group work. Suggested categories:

1. Something non-living
2. An insulator and a conductor
3. Something where a chemical reaction is taking place
4. Something which is not biodegradable
5. Something which shows an inherited characteristic

	6. A solid, a liquid and a gas ***Observations outside (15mins)*** Groups should be given a stop clock set to alarm following the allocated time period, and a designated gathering space within the school grounds. Invisible boundaries should also be set. Groups then collect examples of materials for each category. Moving between the groups, questions should be asked to challenge example choices; why is x a better example than y; what scientific processes can you 'observe' in that example; if you could fit a perfect example into the category what would it be? ***Sharing ideas and provoking conflict (15-20mins)*** Have six sheets laid out with one science category from the egg box list. Each group puts their "items" on to the different sheets. The different groups look in detail at the range of items selected to represent the categories and answer the following questions: What questions do you have about other group's choices? What is the same and what is different about group's choices? Which of the items best reflect the category and why? Are there any choices which you are uncertain about? Which three things would you like to find out more about and why? If you could go beyond the school grounds what else could you add to your collection? Groups can be asked to explain their decisions. They might be challenged to reconsider the science process they considered to be taking place. ***Linking ideas together (15-20mins)*** **What kinds of things have you been talking about and thinking about today?What did you find challenging?** Ask pupils to reconsider their group work rules. **What was their role in their group? Do they think they worked well as a group? What other rules could help the group to be more successful outside next time?** These should be recorded. ***Mathematical plug-ins*** Below is a list of possible mathematical categories. 1. A regular shape with an even number of lines of symmetry (e.g. something square or hexagonal) 2. A quadrilateral with exactly one pair of parallel lines (e.g. something that's a trapezium, maybe a roof) 3. Congruent tessellating shapes (e.g. equal sided tiling) 4. A shape with too many rotational symmetries to count (e.g. anything circular, use this to bring up the idea of infinity in later discussion) 5. Mathematically 'similar shapes' (e.g. a whole window compared to one of its four panes) 6. Something with a small volume and a big surface area (e.g. a leaf)

Appendix 3 'Thinking Beyond the Classroom' activities: Associated aspects of science

Activity Name	Science context	How Science Works link
Air pollution	Chemistry: Air pollution Human activity can lead to changes in the environment	Making observations and inferences, evaluating scientific evidence and working methods
Forces all around us	Physics: Forces Forces acting upon an object can make it move, increase speed and make it stop. For example, a flower blowing in the wind displays numerous forces acting upon it.	Using scientific ideas and models to explain phenomena. Critically analysing and evaluating evidence from observations.
Our School: Urban Jungle	Biology: Food chains Organisms need a range of living and non-living resources to survive.	Obtain, record and analyse data from a wide range of sources. Contribute to presentations and discussions.
Seeing the world through rose tinted glasses	Physics: Colour The colour of an object depends on the wavelengths of light that are scattered and absorbed.	Contribute to discussion about scientific ideas
Egg box	General science skills	Assessing risk, making observations and carry out group work
Back to the sun	Physics: Energy Energy can be transferred from one thing to another and from one location to another.	Using scientific ideas and models to explain phenomena. Critically analysing and evaluating evidence from observations.
Framing and describing	General science skills	Learning how to observe
Looking and observing	General science skills	Learning how to observe
Materials in our schools	Chemistry: Materials and their properties	Using scientific ideas and models to explain phenomena.
Turning over a new leaf	Biology: Variation Living things are interdependent, interacting with each other and their environment	Obtain, record and analyse data from sources, and use findings to provide evidence for scientific explanations

Appendix 4 Reflective journal instructions

RE: Reflective Learning Journals

The notebook should enable you to document and reflect on your learning journey at the end of the year. This notebook is a private document that you can choose to share parts of with your peers and with the PD providers to help you to develop further as a reflective practitioner.

Use the journal how you wish. Your entries could be structured using headings. They might be lists or perhaps just short paragraphs of thoughts on a particular subject (e.g. AfL, CA or group management). Questions that may help include:

- What did I learn from the PD session?
- How did it make me feel professionally?
- How did the students interact with the activity?
- What was challenging for the students/ for you as a teacher?
- What pedagogical skills do you need to further develop though the next activity?

Please bring this along to the next PD session.

Appendix 5 'Thinking Beyond the Classroom' session agenda

Agenda

Wednesday 5th March 2008

Camley Street Natural Park 1pm – 4.00pm

1.00pm	Lunch – travel expenses
1.30pm	Introduction to Camley Street Natural Park.
1.40pm	Reflection on progress so far

Reflections and experiences of transferring the ideas into classroom practice

Individual reflections on activities done so far

- How was the experience different to teaching and learning in the classroom? (from a teacher and student perspective)
- How did you enable group work? (Establishing groups and ground rules, managing whole and small group discussion)

Small group discussion

- Talk about the different ways that you used the activity, how you incorporated it within your existing plans and how else you could have used it.

Pull ideas together as a whole group

2.20pm "Rose tinted Glasses" – Introduction to fifth activity

Reflection on the role and use of questioning;

What were the key questions? What kinds of/levels of understanding might your students reveal in their responses to these questions? How might you develop discussion within your classes?

3.20pm "Materials trail" – sixth activity

Read through lesson outline

What would the key questions for this activity be?

3.45pm Evaluation/Final thoughts/Next steps

Book provisional visits

4.00pm Finish

Appendix 6 Example of letter sent to teachers outlining programme purpose

[Date]

Dear Colleagues,

RE: Thinking Beyond the Urban Classroom

I am writing to welcome you formally to the Thinking Beyond the Urban Classroom project and to introduce myself, Melissa Glackin, as the project officer. This innovative project aims to develop and trial, in collaboration with the project teachers, KS3 science materials that use contexts beyond the classroom to stimulate interest and develop scientific understanding. It involves a total of ten schools from which pairs of teachers from individual science departments are asked to commit to three half day workshops over the course of this academic year – with the potential to continue into Year 2.

The first professional development workshop is to be held on Tuesday 6th November at Mile End Ecology Park (1-4pm). Lunch will be provided from 1pm. Please find the agenda, contact details, a project outline and the dates for the following two workshops attached. These will be held at different venues. Late in the Autumn term a personalised support visit will be arranged with you so that the materials can be observed, evaluated and refined.

Can you please email to confirm your place on this project and inform me of the names and emails of the two teachers from your school who are to be involved.

Supply cover will be fully reimbursed for all of the workshops and travel expenses will be paid on the day.

Best wishes,

Melissa Glackin

Appendix 7 Example of student information sheet and research consent

REC Protocol Number : **REP(EM)/07/08-38**

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Thinking Beyond the Urban Classroom

Student Information Sheet

We are writing to ask you to participate in this original research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please read the following information carefully and discuss it with your parents and teachers if you wish. Ask us if there is anything that is not clear or if you would like more information.

The project aims to develop and trial, in collaboration with your class teacher, key stage 3 science materials that use areas outside of the classroom to stimulate interest and develop scientific understanding. As part of this project, we are investigating pupils' participation in the lessons and what they are learning from the activities. We are also investigating teachers' experience of the professional development days and of the activities.

If you take part in the research, you will be videotaped while being taught in up to three lessons where the materials are being trialled. Notes of observations will also be taken. In addition, before and after the lesson a researcher may interview pupils about the ideas covered in the lesson and your enjoyment of it. These interviews will be audio recorded (but not video recorded).

Your involvement may help you reflect on your learning, as well as helping us to improve the activities for other schools' use. We do not expect you to experience any risks or discomfort. However, a decision to withdraw at any time, or a decision not to take part, will not affect the standard of education you receive. You may also withdraw your data from the project at any time, up until July 2009.

Only the researchers, will see any video recordings of the lessons. Only the researchers will hear the recordings of the interviews. Written examples from the interviews may be shared with other researchers, but your identity will remain hidden. Only the researcher will be able to connect the data to your school.

It is up to you to decide whether or not to take part or not. If you decide to take part, you are free to withdraw from the research at any time and without giving a reason. If you would like more information, please contact me at justin.dillon@kcl.ac.uk or Melissa Glackin at melissa.glackin@kcl.ac.uk .

If this study has harmed you in any way you can contact King's College London using the details below for further advice and information.

Yours sincerely

Dr Justin Dillon
Senior Lecturer in Science and Environmental Education

Head of the Science and Technology Education Group
King's College London

Consent Form

Please complete this form after you have read the Information Sheet.

Title of Study: Thinking Beyond the Urban Classroom

King's College Research Ethics Committee REF: (EM)/07/08-38

Thank you for considering taking part in this research. On behalf of the researcher your teacher must explain the project to you before you agree to take part.

If you have any questions arising from the Information Sheet given to you, please ask your teacher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I understand that if I decide at any time during the research that I no longer wish to participate, I can notify the researchers involved and be withdrawn from it immediately.

I consent to the processing of my personal information (name & school name) for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.

Participant's statement:

I ____ agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet, and understand what the research study involves.

Signed Date

Researcher's Statement:

I confirm (Justin Dillon/ Melissa Glackin (delete as appropriate)) that I have carefully explained the nature, demands and foreseeable risks (where applicable) of the proposed research to the teacher, who will explain this to the pupils.

Signed: Date:

Appendix 8 Example of 'Thinking Beyond the Classroom' session evaluation

Thinking Beyond the Urban Classroom Session Evaluation

Name:

Do you feel that the aims of the day have been met? Which part of the day did you find most rewarding? Why?

On a scale of 0 – 9 (0 being lowest), how confident do you feel to teach:

1. Rose tinted glasses	0 1 2 3 4 5 6 7 8 9
2. Materials	0 1 2 3 4 5 6 7 8 9

Can you explain your response:

Is there anything that you would like from us that would increase your confidence with the project and the activities?

Reflect on one idea that you have been struck by today. How can you implement this in your classroom?

Have you any other question/comments?

Thank you

Appendix 9 Lesson observation support sheet

Observations should focus on the following three areas:

- How teachers are using the outdoors – what are they doing outside?

- Group work (is it happening? What is done in groups?)

- Discussion (between teachers and students – is it happening, what does it look like overall?)

More specifically, observations should note the presence/absence of the following (with short descriptions of what is done and a few more specific instances if possible):

1. Setting the scene – what kinds of questions are teachers asking to set the scene? (It is worth knowing that in the design of the activities, the setting the scene bit (all in class) is broken down into a section where the teacher is supposed to get the class to discuss what working in a group means, what kinds of things you need to do to work well as a group and possible health and safety points and another section where the teacher established what students might know already about the focus of the main activity outside, using something simple and concrete (like a photograph) to trigger ideas, elicit prior understanding and assess where they are at before they start.

2. Observation and collecting data – are teachers encouraging this? How are they facilitating this? How are they using the outdoor space to promote learning? The 'Outdoors' in these activities can range from any space outside of the classroom (the hall, the library etc.) through to the immediate outside (the playground, the street in front of the school) and to environments further away (the local park, an environment centre/park, a field trip). Collecting data might be about making sketches, taking photographs, collecting leaves, or just making notes of what they see outside.

3. Sharing and challenging ideas – is the teacher eliciting/gathering students' ideas? Is the teacher encouraging students to challenge each other's ideas? So lots of, who agrees…, who disagrees, what do you think about that idea…? Can anyone think of another way…?

4. Linking ideas together and reflection – is the teacher doing this? (How?) Is the teacher encouraging/facilitating students to reflect on what they have experienced and learned? You should hear teacher questions like, what was difficult…? How did you decide…? If you could improve on…what would you do…?

[If the above four areas are noted and described, they will also address the three broader areas of interest above…]

Structure:

In addition, field notes should also reflect the timings and structure of the lessons and how they are organised. That is, they should note how long the different components (1-4 above) last and when/how students are working as a whole (class) group, small groups or individuals.

Appendix 10 Example of research interview questions (*Aide Memoire)*

Observed lesson:

How do you feel the lesson went?

What were the lesson objectives? Were they achieved?

Why did you choose to do *[insert]* and *[insert]* in the lesson?

What planning was required to teach the activity?

Programme's influence:

To date, what's your understanding of the main goals of the programme?

And do you think that they were achieved?

What do you see professional development (PD) as?

What were your impressions of the PD sessions?

How does the PD compared with other PD courses?

Which activities have you tried?

What determined the choice of the activity that you have trailed?

Have you used the outdoors in other lessons, other than those from the programme?

Can you tell me about one of these lessons? What was the purpose? Why did you use the outdoors over other resources?

Programme framework:

How did the group work go?

How do you feel your skills developed within this area over the project? Can you give me any examples of this?

How did asking students to reflect on their own learning go?

How do you feel your skills developed within this area over the project? Can you give me any examples of this?

In terms of questioning, were you able to incorporate those kinds of open questions into your 'outdoor lessons'?

How do you feel your skills developed within this area over the project? Can you give me any examples of this?

What would you say is the value of asking those kinds of (open-ended, cog chall) questions?

How did these activities differ when outside the classroom?

Time outside:

A question now on spending time outside – how, has this changed developed? What do you find you are doing outside?

What is your role outside?

What benefits do you think there are to working outside in the school grounds?

And what did you find challenging about the lessons?

Have these challenges changed over the course of the year?

Student response:

And how did the students respond to the lessons?

And in terms of what they were taking on board – the activities, did they get much out of them?

What have the students gained?

Personal/ departmental:

Did working with a colleague on the project bring any benefits? If so what?

Were you able to integrate any of the lessons into a scheme of work?

Did working with a colleague on the project bring any benefits? If so what?

Did you feel supported by your department / school with being involved? What is your school policy for PD?

So, would you recommend the professional development over other CPD sessions to other teachers?

Do you feel like participating in the programme has influenced you or your teaching in any way? Why did you continue in the project?

Which skills/ areas do you plan to further develop through the next activity you teach?

Appendix 11 Emailed 'Professional information questions'

1. What are your qualifications?
2. What is your teaching experience?
3. Do you have additional responsibility in school?
4. List the PD sessions you have attended over the last four years:
5. From the Thinking Beyond the Classroom PD programme which activities have you attempted?
6. How do you think children learn?
7. Why is science taught in schools?

Appendix 12 Modified Science Teacher Efficacy Belief Instrument (STEBI)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA = Strongly Agree

A = Agree

UN = Uncertain

D = Disagree

SD= Strongly Disagree

1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2. I am continually finding better ways to teach science.	SA A UN D SD
3. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	SA A UN D SD
4. I know the steps necessary to teach science concepts effectively.	SA A UN D SD
5. I am not very effective in organising science enquiry lessons.	SA A UN D SD
6. If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
7. I generally teach science ineffectively.	SA A UN D SD
8. The inadequacy of a student's science background can be overcome by good teaching.	SA A UN D SD
9. The low science achievement of some students cannot generally be blamed on their teachers.	SA A UN D SD
10. When a low achieving child progresses in science, it is due to extra attention given by the teacher.	SA A UN D SD
11. I understand science concepts well enough to be effective in teaching science outside the classroom.	SA A UN D SD
12. Increased effort in science teaching produces little change in students' science achievement.	SA A UN D SD
13. The teacher is generally responsible for the achievement of students in science.	SA A UN D SD
14. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA A UN D SD
15. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	SA A UN D SD
16. I find it difficult to explain to students why science experiments work.	SA A UN D SD
17. I am typically able to answer students' science questions.	SA A UN D SD
18. I wonder if I have the necessary skills to teach science outside the classroom.	SA A UN D SD
19. Effectiveness in science teaching has little influence on the achievement of students with low motivation.	SA A UN D SD
20. Given a choice, I would not invite the head teacher to evaluate my science teaching.	SA A UN D SD
21. When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.	SA A UN D SD
22. When teaching science, I usually welcome student questions.	SA A UN D SD
23. I don't know what to do to turn students on to science.	SA A UN D SD
24. Even teachers with good science teaching abilities cannot help some kids learn science.	SA A UN D SD

Appendix 13 Reflection sheet for 'Thinking Beyond the Classroom'

Name:	**Activity name:**
Year group/ ability:	Total number of activities completed with class:

Describe the main conflict/ challenge of the activity.

How did the pupils respond to the challenge?

What 'good' questions did you use in this lesson? Why do you perceive them as 'good'? (e.g. what range of answers did they illicit?)

How was the outdoors used by pupils within this lesson? Were there any surprise uses or findings (e.g. examples)?

What skills do you plan to further develop/ focus on through the next activity you teach?

Appendix 14 Evaluation report for 'Thinking Beyond the Classroom' (2007-08)

Thinking Beyond the Urban Classroom

Evaluation report prepared for

King's College London

1 August 2008

08-00

Executive Summary

The primary findings from the evaluation of Thinking Beyond the Urban Classroom are as follows:

The project was successful in achieving its primary aims of developing a set of innovative teaching resources for teachers of science at Key Stage 3 which can be used in the outdoor classroom and which incorporate best practice in terms of assessment for learning and cognitive acceleration, and in training a group of inner-London teachers in their use.

Teachers expressed enthusiasm for the activities and the continuing professional development (CPD) sessions.

Participating teachers implemented between two and six of the activities with their students.

Teachers successfully incorporated most phases of the activity (Setting the scene, Observation and collecting data, Sharing and challenging ideas) into their lessons. However, time constraints generally prevented them from including the ‘Linking ideas together and reflection’ phase of the lesson.

Teachers used groupwork and open-ended questions in implementing the activity and became more confident in these areas during the course of the project. Teachers also attempted to use groupwork and open-ended questions in additional lessons, unconnected to the project.

Logistical issues connected to taking students outside (e.g. time constraints, behaviour management) were possibly the biggest challenges teachers faced. However, these concerns did not dampen teacher enthusiasm for the activities or for the project as a whole.

Teachers became more comfortable with taking their students outside during the course of the project. In addition, several teachers were motivated to take their students outside in lessons unconnected to the project.

The project increased teachers’ awareness of ways the outdoors can be used to teach science, beyond ecology and biology.

Teachers shared their experience and the activities with colleagues, both formally and informally, with several incorporating the activities into Key Stage 3 schemes of work for next year.

Teachers felt the activities had impacted on their students’ learning in multiple ways, including by increasing motivation, providing students with an enjoyable experience, increasing their awareness of their surroundings, improving their appreciation and understanding of science generally, and supporting content and social learning.

Teachers found the CPD to be enjoyable and helpful, and the sessions were well attended. Teachers particularly valued the opportunity to try the activities, to discuss their experience with other teachers and to gain tips for managing the activities.

Students expressed enthusiasm for the activities and interest in going outdoors. They also felt the activities benefitted their learning.

The impact of the project is likely to be extended further via the King's College London PGCE course and the Field Studies Council's teacher training.

Introduction

Given the growing body of evidence of the benefits of learning outside the classroom, the Thinking Beyond the Urban Classroom project aimed to train a cohort of urban teachers to teach science effectively outdoors. The project drew upon lessons learned from previous research about promoting thinking in science and continuing professional development (CPD). In this project a set of eight learning activities were developed, which incorporated best practice in assessment for learning (AfL) and cognitive acceleration (CASE). Teachers from inner-London schools received training in these activities during three CPD sessions, which focused on the activities themselves, as well as their underlying pedagogy – AfL, CASE and outdoor learning.

More specifically, the aims of the project were:

To develop and evaluate a set of innovative teaching resources for teachers of science at KS3 which can be used in the outdoor classroom and which incorporate best practice in terms of assessment for learning and cognitive acceleration;

To train a group of inner-London teachers in the use of the teaching resources and to support them in the use of the materials with KS3 classes;

To evaluate the successes of the project in terms of materials and training strategies and to disseminate the findings widely.

The success criteria for the project are provided in more detail in the appendix. They included measures related to whether and how teachers implemented the activities, with a particular emphasis on attempts to incorporate groupwork and open-ended questioning strategies into their teaching. They also included whether teachers intend to use the activities in the following year and evidence of positive student reactions to the activities.

Methods

A combination of methods was used in order to assess the project. Interviews and observations, as well as document review, were conducted to gain insight into the success of the activities (e.g., into teachers' and students' experience of them) and into the effectiveness of the CPD. More specifically, two of the three CPD sessions were observed, and feedback forms were collected from teachers after all three sessions. In addition, in two of the CPD sessions additional forms were used to encourage teachers to reflect on their experience with the activities, and these were also collected.

Lesson observations were also conducted by both the project officer and the evaluator. These observations focused on elements of interest to the programme, namely, how teachers were using the outdoors, groupwork, and discussion and questioning. The observations were also structured around the four parts of each lesson: 'Setting the scene', 'Observation and collecting data', 'Sharing and challenging ideas', and 'Linking ideas together and reflection'. Because the observations were structured around these particular guidelines, it was possible to use observations collected by both the project officer and the evaluator to inform this evaluation. This proved to be particularly key because it was only possible for the evaluator to conduct observations in three of the ten participating schools, due to teachers' and schools' time constraints. A total of 13 observations (nine by the project officer and four by the evaluator) were conducted, and these represent a total of seven schools.

In addition to the observations, a series of teacher interviews were conducted, to understand more clearly teachers' perceptions of the programme – of the activities and the CPD. These interviews explored teachers' experience with the activities and their perceptions of students' responses to them, their comfort level with conducting activities outside, their efforts to use groupwork and Assessment for Learning types of questions (e.g. open-ended), and their intentions to use groupwork and questioning strategies, as well as the activities themselves, in the future. Teachers were also questioned about their experience of the CPD sessions – of their effectiveness and how they compared with other CPD the teachers had attended. In total nine interviews (of teachers from six schools) were conducted by the evaluator.

Finally, nine interviews were conducted with the project team. Three members were interviewed twice – once part way through the project and again at the end. These interviews were intended to gather team members' perceptions of the project and possible impacts it might have on teachers and their use of the outdoors.

These various sources of data – teacher feedback and evaluation forms, observations of CPD sessions and lessons, teacher interviews, and project team interviews – have been combined to evaluate the programme against the success criteria. A full list of these criteria is included in the appendix, but includes teacher attendance at and positive responses to the CPD, implementation of at least two activities; increased comfort level with, and interest in, using the outdoors for teaching; intentions to continue with the activities next year; attempts to incorporate groupwork and open-ended questioning strategies into their teaching; and positive student responses to the activities.

Findings

The evaluation shows that the project was successful in achieving its main aims of developing a set of innovative teaching resources and training teachers in their use. Moreover, evidence was found in support of all of the success criteria, and this highlights where the particular strengths of the programme lay, as well as areas for further improvement. The remainder of this section details the evaluation findings in five key areas:

Implementation of activities

Impacts on teachers

Potential impacts on students

CPD sessions

Other outcomes

Implementation of activities

Nearly all of the teachers who participated in the programme taught at least two of the lessons, with most teaching more. Of the nine teachers who were interviewed (and two additional teachers who were observed by the project officer but who could not be interviewed), all but one had conducted at least three lessons, two teachers had tried four and one had tried six. In addition, most of these teachers had taught the lessons to more than one class.

Teachers generally spoke quite positively about the activities, particularly the way students responded to them. (See section 3.3 below for more about the perceived impact of the activities on students.) Observations of lessons confirmed that teachers attempted most parts of the lesson: 'Setting the scene', 'Observation and collecting data' and 'Sharing and challenging ideas'. However, time constraints of the lessons prevented teachers from implementing the final section of 'Linking ideas together and reflection'. That this was an issue for most teachers suggests that the activities as originally written may have tried to fit too much into the time available to teachers for most lessons.

Teachers were observed leading the following activities: Turning Over a New Leaf, Back to the Sun, Urban Jungle, Rose-Tinted Glasses, and Forces All Around Us. All of the teachers used the 'Setting the scene' component of the lesson to review and elicit students' ideas relevant to the topic of the activity, and most engaged students in some talk about working in groups. The two who did not emphasise groupwork in this point in the lesson were teaching classes who were very experienced with groupwork, making such an emphasis unnecessary. However, most of the teachers encouraged students to discuss questions with their peers during this phase of the lesson.

In the ‘Observation and collecting data’ phase of the lessons, all students in the observed activities worked in groups, and most teachers actively encouraged students to talk with each other about what they were observing and finding. Teachers utilised a variety of outdoor spaces around their schools, from netball pitches, to woods, to asphalt play areas, to grassy lawns. Although teachers necessarily spent time simply managing their classes and keeping students on track with the activities, some also managed to ask open-ended questions which were likely to encourage their thinking. For instance, questions asked outside included ‘Why do you think it looks like that?’ and ‘How would you describe that habitat?’

Although these efforts were likely to engage students with the activity (and observations revealed that they were engaged), the time available for this phase of the lesson was generally between 10-15 minutes, at best, due to the amount of time needed to get students outside and then back in again.

All of the lessons observed contained the ‘Sharing and challenging ideas’ phase, although this phase varied in length from 5 to nearly 20 minutes, depending on the amount of time available. In this phase teachers attempted to elicit students’ ideas with open-ended questions, and many invited students to share their ideas and to challenge each others’ ideas. Students were also often encouraged to discuss their observations with each other, before sharing them with the class. For instance, in the Rose-Tinted Glasses lesson, a teacher asked students what was similar and different between red and green tinted glasses and what might be reasons for any differences. As pupils shared their answers, he asked students to justify their responses and queried others whether they agreed or disagreed. Another teacher, in this phase of the Urban Jungle lesson, asked students open-ended questions such as ‘How can thinking about what things eat support her (another student’s) definition of a good habitat?’ She also encouraged them to think and share ideas about how they might get more accurate samples.

Only one of the teachers observed was able to incorporate the ‘Linking ideas together and reflection’ phase of the lesson – all of the others ran out of time. (The lesson she taught was approximately 90 minutes long.) She encouraged students to talk about what they would do differently if they could do the lesson again, and to share what they had learned.

Overall, observations of several teachers leading a variety of lessons revealed that they did, not surprisingly, make use of the outdoors and that they incorporated groupwork in various ways, particularly by assigning roles, by inviting students to develop rules and by encouraging discussion and sharing ideas in groups. In interviews teachers also described their efforts to use groupwork, particularly how they had organised their students and encouraged them to discuss ideas with each other. A few noted that groupwork had been challenging initially, particularly with some of their students, but they had continued working on it and that it had become easier and smoother over time.

Teachers also attempted to incorporate into their lessons open-ended questions that would elicit and encourage critical thinking, albeit with varying degrees of success. That is, some teachers seemed to include more such questions in their lessons than others, and some questions seemed to encourage longer and more elaborate student responses than others. In the interviews teachers confirmed that they had attempted to incorporate these kinds of questions into their teaching, and that they had been mindful of doing so, although some acknowledged that doing so can be challenging. In addition, some had been trained in these kinds of questioning strategies, for instance as a part of their PGCE courses. However, this was an element of the programme that some teachers also seemed to find more challenging in the CPD sessions, which suggests that more support may need to be given to this aspect of the programme in the future, a suggestion echoed by the project team as well.

Finally, observations also highlighted the logistical challenges inherent in taking students out of doors – teachers necessarily had to spend a good deal of time managing the activity, and generally found it difficult to incorporate the later two phases of the lesson, particularly ‘Linking ideas together and reflection’. This observation was confirmed by interviews with teachers, in which they all commented on management and logistical concerns as being the biggest challenge they faced in implementing the activities. These ranged from the weather, to clean up, to focusing students when they were outside, to the teacher-student ratios needed, to concerns about disrupting other classes, to simply the amount of time needed to get students outside and then back in again. Transitions from one part of the activity to another were particularly challenging, and do not seem to have been fully accounted for in the lesson plans. Relatedly, teachers also noted that the opportunity to discuss logistical issues and get management ‘tips’ from other teachers during the CPD sessions was one of the most valuable aspects of those days.

These hurdles did not seem to diminish teachers’ enthusiasm for the activities, expressed both in the CPD sessions and in the interviews and also reflected in their intentions to continue with the activities next year. Indeed, several teachers remarked that although they had not been able to incorporate the activities into schemes of work this year, that they were in the process of doing so for next year. Three of the teachers also explicitly noted that the activities fit well with the new Key Stage 3 curriculum, particularly How Science Works. Thus, the activities would certainly be shared and disseminated among their colleagues. In addition, their enthusiasm for the programme had already led seven to share them with their colleagues, either informally or via departmental meetings.

Impacts on teachers

Beyond implementing the activities and sharing them with colleagues, the programme seems to have been successful in achieving other impacts on teachers as well – particularly on their comfort level with taking students outside and their perceptions of how the outdoors may be used for teaching science. It also impacted on their attitudes towards groupwork and their efforts to incorporate open-ended questioning strategies. In interviews, as well as in the CPD sessions, teachers' enthusiasm for taking students outdoors was apparent. In the interviews in particular, teachers remarked on the way in which the programme, and trying the activities, had given them the confidence to take students outdoors. They discovered that it can be done and that it is enjoyable, and the way students had responded to the activities and to being outdoors encouraged them to actively seek opportunities to do so in the future. Even the teachers who had been reasonably confident to begin with felt that the programme had increased their skills and confidence in leading activities outdoors. All of the teachers claimed they would look for other opportunities to take students outdoors in the following year, and five noted that they had already taken students outside for other lessons, unrelated to this project.

"I'm beginning to form my own ideas about learning outside the classroom. If I have my own topic, I can kind of design it in such a way that it becomes an outdoor activity." Teacher

The programme also seems to have impacted teachers' perceptions of how the outdoors can be used and of the benefits to taking students outdoors. Teachers who were interviewed made the point that they now realise the outdoors can be used for more than just ecology or biology, and that it can help connect students to science and help them realise that science is part of their everyday lives in a way that classroom lessons cannot.

"For physics, for example, we were looking at aerodynamics. So, instead of just doing it in the classroom, we actually made paper aeroplanes of different shapes and went outside to test them." Teacher

Although many of the teachers had been using groupwork and open-ended questioning prior to the project, they believed that it had increased their awareness, confidence and skills in doing both. All of the teachers interviewed commented that they were using groupwork and open-ended questioning with all of their classes, not just the ones with whom they had implemented activities from this project, and would continue to do so in the upcoming year.

"I've kind of adopted the groupwork kind of way, with a lot of my other classes." Teacher

Another teacher commented that the programme had impacted on his teaching:

"In terms of questioning and that type of questioning – sort of open-ended and trying to promote real thinking and learning. And thinking about groupwork, and thinking outside the box about trying to use the outdoors a bit more." Teacher

This impact would seem to be attributable to both the experience of implementing the activities, as well as to the CPD, which seemed to have encouraged teachers to reflect on groupwork and questioning, even if these were techniques the teachers had been focusing on prior to the project. For instance in the third CPD session, teachers completed reflection sheets which highlighted their attempts to ask open-ended questions and made salient their intentions to focus on groupwork in future lessons. In addition, the feedback forms also reflected that the CPD sessions had raised their awareness of how teachers can use outdoor space and made them think about how to organise groupwork and discussion and as well as about the way they were asking questions. That these aspects of the programme were salient to them was also reflected in their perceptions of the purpose of the project, which they remarked as being not just about taking students outside – though that was a key element – but about groupwork and open-ended questioning as well.

Impacts on students

Although directly measuring student impact (e.g. via pre and post tests) was outside of the scope of this evaluation, some insight into the impacts of these activities on students was gained from interviews with teachers. In addition, during the observations, a small number of students were questioned informally about their experience of the lessons.

Students tended to respond enthusiastically to the activities and to going outside. This enthusiasm was noted by the teachers and was also observed by the project officer and evaluator. A few students were asked directly and they remarked that they enjoyed the activities and going outside, and preferred them to regular lessons in the classroom. For instance, one student said lessons outdoors were better:

"Because some people might not learn as well out of books – so it helps to go outside and really see it. You can understand it better when you see it outside. It's fun and interesting and helps focus your mind on things." Student

A student from another school also noted that:

"When you see it with your own eyes, instead of just hearing about it, you learn better." Student

In interviews teachers also noted a number of impacts on students, beyond simply their enjoyment of and enthusiasm for the activities. The teachers felt students had been engaged with the activities and that they had contributed to students' understanding of science content, such as the lesson on light and filters (Rose-tinted glasses). They also believed it increased students' interest in going outside, and several remarked that the lessons had increased students' awareness of their surroundings. For instance, students had become more aware of all the living things in their school grounds and on their route to school. Students also seemed to recognise more of the ways in which forces were acting all around them.

"It has broadened their minds – making those connections and comparisons, and realising they can learn anywhere, not just in the classroom." Teacher

Other teachers felt that the activities had given their students the opportunity to take more initiative or responsibility for their own learning and to think independently and critically, which were valued outcomes. Teachers also believed that they had increased students' appreciation of science more broadly, by contributing to an understanding of how science operates "in the real world" and to a recognition that science is "all round us" and is "a part of real life". Teachers generally valued the way in which the activities seemed to inspire and motivate their students, perhaps because they helped students better relate to the content.

The activities also seemed to have had benefits independent of the science, but still valued by teachers, such as improving students' ability to work with their peers and discuss their ideas or strengthening their "thinking skills". The teachers were also pleased with how much the students themselves felt they had learned from the activities. Another teacher was very impressed with the impact the activities had had on her lower-ability pupils in particular and felt they had gained the most from the activities.

"The activity brought out their interests and really encouraged the lower-ability pupils. I saw things in them that I hadn't seen in the classroom. They were so focussed and interested. As a group, I feel like the lower set learned more, because of the way they were talking about things and how focussed they were." Teacher

CPD sessions

The three CPD sessions formed an integral part of this project, and observations, feedback forms and teacher interviews highlighted elements that contributed to the success of these sessions. That the sessions were successful is reflected in the number of teachers who attended – particularly the second and third sessions. That such a high proportion of teachers returned is an indicator that teachers found the sessions to be helpful. In interviews teachers also spoke favourably about the CPD sessions, and all of those interviewed said they enjoyed the CPD and would recommend it to other teachers.

One of the features of the CPD sessions that teachers found to be particularly valuable, as well as enjoyable, was the opportunity to try the activities, rather than simply having them presented. This was brought out in the feedback forms and interviews, and observations also verified that teachers were very engaged by the activities in the CPD sessions. In interviews all of the teachers remarked that this experience had been positive and helpful, as well as noting that this hands-on element of the CPD made it different from other CPD or INSET sessions they had attended. It was also considered especially beneficial for those who initially lacked confidence in going outside and/or in trying the activities.

"Once you've done it, you've learned it better and can teach it better." Teacher

Another feature that teachers found very helpful was the opportunity to discuss the activities and their experience with them with each other. This sharing of practice and ideas was quite valuable, and contributed to a supportive atmosphere in the CPD sessions. Teachers also particularly appreciated the concrete, practical tips for implementing the activities contributed by their colleagues and, if anything, would have liked even more time for discussion. As with trying the activities, the opportunity to share with other teachers was a positive contrast with other INSETs or CPD.

"It was really good to talk to other people who were doing it, to find out about their experiences. Because when you hear the leaders describe it you think 'oh my goodness, it didn't quite go like that.' But then you hear that others had the same problem – it's quite reassuring to know." Teacher

Another element of the CPD that teachers appreciated was the opportunity to reflect on their practice, including on the use of groupwork and questioning. For some, this aspect of the CPD was less valued than trying the activities and sharing ideas with fellow teachers, but even teachers who felt they were already 'up to speed' with groupwork and questioning believed that further reflection on these areas was generally beneficial.

Other aspects of the CPD that teachers regarded positively included its continuous nature – that it happened over three sessions rather than just one, that each session was very focused and that there was a variety of activities within the sessions. Given their limited time, teachers also appreciated that there was not a lot of "faffing about". Rather, they came away from each session with practical, useful resources they would be able to implement in the classroom.

Although the CPD sessions were regarded very favourably, teachers did make a few suggestions for improvement, many building on the successes of the sessions. More specifically, teachers felt having opportunities to try all of the activities, rather than a subset, would have been particularly helpful. Relatedly, some teachers would have preferred more time being devoted to practical guidance for implementing the activities and for teaching outdoors generally. A few teachers also would have appreciated more specific suggestions for questions they could pose to their students during the lessons. The other suggestion made by several teachers was a request for electronic copies of the materials – the PowerPoint presentations used, as well as the lesson plans.

Further impacts

Beyond the impact of the programme on the teachers directly involved and their students, the reach of the programme extended further, primarily through dissemination activities. More specifically, seven of the nine teachers interviewed described how they had shared the activities with colleagues, either informally or in department meetings, or both. Others were planning to share them with colleagues at future department meetings. In addition, eight of the nine teachers interviewed were incorporating the lessons into departmental schemes of work for the upcoming year, ensuring that other teachers implement them and that larger numbers of students experience them.

In addition, the project team is also disseminating aspects from the project more widely. It is feeding into a PGCE course at King's College London, as well as being applied to teacher training by the Field Studies Council.

Conclusions

In summary, it appears that the Thinking Beyond the Urban Classroom project was successful in achieving its objectives and having an impact on both the teachers who participated and their students. Participating teachers implemented the activities, spoke positively about them and felt their students gained from the experience. Teachers consistently used groupwork in these lessons – as well as in others unconnected to this project – and attempted to use more open-ended questioning strategies. In conducting the activities, teachers were able to implement most phases of the lessons – 'Setting the scene', 'Observation and collecting data', and 'Sharing and challenging ideas'. Time constraints generally prohibited them from engaging their students in the final phase of 'Linking ideas together and reflection', which suggests that some restructuring of the activities may be necessary for the future. Teachers' positive responses to the activities are also reflected in their sharing the activities with colleagues, in their intentions to use the activities again in the future and in their incorporation of the activities into next year's schemes of work.

The CPD sessions were also successful. They were well attended and well received, with teachers particularly positive about the opportunities they offered to actually try the activities and to share and discuss their experiences with other teachers. Teachers also valued the tips given (generally by other teachers) for managing the logistics of the activities, which proved to be their most challenging element.

The project was also a success in its impacts on teachers. It seems to have increased their confidence and skills in teaching outdoors, as well as to have broadened their perceptions of the ways the outside can be used for teaching science. Over the course of the project, teachers also became more comfortable with – and seemingly more skilled at – using groupwork in their lessons and in asking more open-ended questions of their students.

Finally, the project seems to have been a positive experience for the students who participated. They clearly enjoyed the experience and expressed enthusiasm for going outdoors. The activities also seem to have increased their awareness of their surroundings. Teachers also felt that it contributed to an understanding of the nature of science and gave students the opportunity to work more autonomously.

Appendix

Success criteria for the project

Good teacher turnout at CPD days

Teacher enthusiasm for activities and programme overall

Teachers implement activities (at least 2-3) with their students

Teachers share their experience with other teachers in their departments/schools

Teachers feel more comfortable with going outside with their students

Teachers attempt to integrate activities in their schemes of work and/or intend to do so next year.

Teachers intend to continue using the activities (and going outdoors) next year.

Teachers use groupwork in implementing the activities.

Teachers feel more comfortable with groupwork.

Teachers intend to try to use groupwork in other lessons.

Teachers appreciate the role of open-ended questioning.

Teachers ask open-ended questions in leading activities.

Teachers intend to work on the questions they ask in future lessons.

Students express enthusiasm for and interest in the activities and in going outdoors for lessons.

Appendix 15 Examples of emerging codes for teacher beliefs

Category	Code	Examples of incidents within code	Relevant data source
Beliefs related to pedagogical practice	On questioning	How questioning will be implemented in school	PD-session evaluation Reflection sheet
		What the purpose of questioning was within the lesson	Interview
		How questions were used within the lesson	Lesson observation
	Group work	How group work will be implemented in school	PD-session evaluation Reflection sheet
		What the purpose of group work was within the lesson	Interview
		How group work was used within the lesson	Lesson observation
	Observing outside	How observation will be developed outside	PD-session evaluation Reflection sheet
		What the purpose is of teaching observation skills	Interview
		How observation skills were developed	Lesson observation

	Cognitive challenge	How cognitive challenge will be developed	PD-session evaluation
		What the purpose is of cognitive challenge	Interview
		How cognitive challenge was incorporated	Lesson observation
Beliefs related to the ‘outdoor classroom’	Teaching outside	How the teacher perceived their role outside	Interview
	Learning outside	What students might (or might not) learn by teaching outside	Interview
	Managing students	How should student learning be managed	Interviews Lesson observations
Beliefs related to teaching and learning	Learning	How students learn	Professional information questions Interview Lesson observation
	Teaching	How teachers should teach	Professional information questions Interview Lesson observation
Beliefs related to science and school science	Science	What is the purpose of learning science	Professional information questions

			Interview
		What is the purpose of school science	Professional information questions Interview Lesson observations
Beliefs related to PD and PD programmes	PD	What is the purpose of teachers' PD	Interview
		What is the purpose of the PD programme	PD-session evaluations Interview Lesson observations
		What should be included in a PD programme	Interviews PD-session evaluations

Appendix 16 Teachers' confidence rating for 'Thinking Beyond the Classroom' activities

Data source - Session evaluation (Confidence scale 0-9 (0 as lowest))

Session activity introduced	Activity	Megan	Claire	Charlie	Cara	Tom	Michael	Activity average
1	Eggbox	9	9	9	8	-	9	8.8
	Forces around us	7	8	7	8	-	9	7.8
	Back to the Sun	6	6	7	6	-	6	6.2
	Turning over a new Leaf	6	6	8	6	-	6	6.4
2	Rose tinted glasses	9	8	6	6	3	7	6.5
	Materials	7	5	5	7	8	3	5.8
3	Our school: Urban Jungle	8	7	9	-	9	8	8.2
	Air pollution	6	3	5	-	6	6	5.2
4	Observation 1 & 2	9	8	7	-	-	9	8.3
Confidence average		6.4	6.7	7	6.8	6.5	7	

Appendix 17 STEBI score for case study teachers

Case study teacher	Personal science teaching efficacy (max. 60)	Science teaching outcome expectancy (max. 60)	STEBI score (max. 120)	Teacher efficacy description
Charlie Pence	51	36	87	High
Michael Bison	56	42	98	Very high
Megan Thomas	58	42	90	Very high
Tom Peterson	54	41	95	Very high
Claire Westwood	53	34	87	High
Cara Brown	53	34	87	High

Appendix 18 Example of coding for professional development strategies

Category	Code
Programme session *(Focus on whole activity)*	Activities 'acted out' – tutor led
	Activity read through and 'props' presented
	Group discussion and evaluation of an activity
	Activity developed within a group
	Receipt of activity props/resources
	Receipt of activity lesson plan: clear obj/NC links
	Sequence of sessions with follow-up/review
	Authenticity of programme - theory and tutors
	Clear pedagogical framework - transferable to other lessons
Programme session *(Focus on specific aspects of pedagogy framework)*	Aspect: Observation *A tutor-led activity to develop teaching observation skills to students*
	A teacher-led activity to develop student observation
	Aspect: Group work Theoretical ideas presented on group work
	Aspect: Cognitive conflict (CC) An activity to identify the CC in the lesson activities through discussion
	Aspect: Questioning Writing questions for the activities with the support of 'question stems'
Programme session (Focus on student management)	Strategies to manage students outside presented by a participating teacher
	Strategies to manage students outside shared in groups
	Strategies to manage students outside presented by tutor during activity teaching
In school	Generally trialling activities
	Trialling and adapting activities with a range of classes
	Sharing ideas with a colleague/student teacher
	Observing new teacher/student teacher trial lessons
	Sharing activities with department: formally/informally
Other	Reflecting in journal
	Through lesson observation/feedback from programme tutor
	Through research interviews
	Presenting in conferences
	Completing a research study (M-level)

Appendix 19 Example of teacher information sheet and consent form

REC Protocol Number REF (EM)/07/08-38

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

Thinking Beyond the Urban Classroom

We are writing to ask you to participate in this original research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information.

The project aims to develop and trial, in collaboration with project teachers, KS3 science materials that use contexts outside of the classroom to stimulate interest and develop scientific understanding. As part of this project, we are investigating students' participation in the lessons and what they are learning from the activities. We are also investigating teachers' experience of the professional development days and of the activities.

If you take part in the research, you will be videotaped while leading up to three lessons in which you are trialling one of the activities. Notes of observations will also be taken. The professional development days will also be observed, but not video recorded. In addition, before and after the lesson a researcher may interview some of your students about the concepts covered in the lesson and their enjoyment of it. You will also be interviewed about possible benefits of the activities, drawbacks or barriers to using the activities, and details of your experience implementing the activities. Questions will also be asked about the professional development days. These interviews will be audio recorded (but not video recorded).

Your participation may help you reflect on the lessons and the professional development days, as well as helping us to improve the activities for other teachers' use. We do not expect you to experience any risks or discomfort. However, a decision to withdraw at any time, or a decision not to take part, will not affect the standard of education your students receive. You may also withdraw your data from the project at any time, up until July 2009.

Only the researchers will see any video recordings of the lessons. Only the researchers will hear the recordings of the interviews. Written examples from the interviews may be shared with other researchers, but you and your students will be completely anonymous. Only the researcher will be able to connect the data to your school.

It is up to you to decide whether or not to take part or not. If you decide to take part, you are free to withdraw from the research at any time and without giving a reason. If you would like more information, please contact me at justin.dillon@kcl.ac.uk or Melissa Glackin at melissa.glackin@kcl.ac.uk.

If this study has harmed you in any way you can contact King's College London using the details below for further advice and information.

Yours sincerely

Dr Justin Dillon
Senior Lecturer in Science and Environmental Education

Head of the Science and Technology Education Group

King's College London

Consent Form

Please complete this form after you have read the Information Sheet.

Title of Study: Thinking Beyond the Urban Classroom

King's College Research Ethics Committee Ref (EM)/07/08-38

Thank you for considering taking part in this research. The person organizing the research must explain the project to you before you agree to take part.

If you have any questions arising from the Information Sheet given to you, please ask the researcher (Justin Dillon/ Melissa Glackin) before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

I understand that if I decide at any time during the research that I no longer wish to participate, I can notify the researchers involved and be withdrawn from it immediately.

I consent to the processing of my personal information (name & school name) for the purposes of this research study. I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.

Participant's statement:

I ____ agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet, and understand what the research study involves.

Signed Date

Researcher's Statement:

I, Justin Dillon/ Melissa Glackin, confirm that I have carefully explained the nature, demands and foreseeable risks (where applicable) of the proposed research to the teacher participant.

Appendix 20 Example of coding for pedagogical practice

Category	Code	Examples
Teaching disposition (outside)	Teacher-centred approach	Teacher dominating all activities outside; limited student-student interaction; teacher acting like a tour guide
	Data collection orientated	Students outside collecting data only
	Student-centred approach	Students working individually or in groups on a task outside; teacher is 'in the background'; teacher interacting with individuals or groups.
Group work (outside)	Pre-planned groups	Teacher reporting how they planned the lessons groups; teacher displaying on the board the groups students are to work
	Students encouraged to take ownership of group work	Students asked to write group rules; students given time to evaluate rules; students are prompted outside to re-consider own rules
	Assessment of group work	Teacher assessing the work produced by a group; students asked to assess their group work; teachers are praising group work
	Students work individually/pairs	Students are working alone or in pairs
	Students taught as whole-class	Students work individually; outside teach acts like tour guide
Challenging thinking (cognitive challenge)	Teacher offers cognitive challenge in the outdoors	Teacher presents a puzzle with 'real' example in outdoors
	Teacher offers cognitive challenge in the classroom – but related to the outdoors	Teacher presents a rusting door hinge to students and asks – what was its function/ was it suitable for the purpose?

Appendix 21 Summary of case study teachers

Case study	Teachers' beliefs	Teacher efficacy	Researchers Perception Teacher Efficacy (RPTE)	Influential professional development (PD) strategy	Implementation of principles of pedagogical framework
Charlie Pence Year 1	**Teaching and learning** Social constructivist approach Student discussion highly valued Dominance of interactive/dialogic teaching **Science Epistemology** More than one-way of understanding the world. Positioned slightly towards 'interpretisim'. **School science** Observed practice portrayed beliefs with a focus on conceptual understanding however articulated beliefs were concerned with student understanding how science was 'made' **Professional development** Sharing good practice: at the PD sessions and with his colleague. Receiving ideas that easily translate into practice. **Teaching / learning outside** Offered - Pedagogical variety; novelty; excitement. Visual aids. Student more likely to misbehave or become off-task. Outside is a source of data collection only	Moderate Mean confidence score 7.25 to teach activities Lower teacher efficacy to teach outside – Due to accessibility of classroom resources and potential student behavioural issues: 'I am more comfortable inside..' (Interview, May 2008)	Moderate **Subject knowledge** Comfortable to trial activities outside subject specialism. However more likely to use 'standard' classroom examples than one's from the outdoors when teaching physics oriented activities rather than the activities which are more general science focused. **Flexibility** Trials a range of activities (5/8) across a range of classes and key stages. Limited variation from that outlined on activity sheet. Trials new pedagogy – such as the inclusion of explicit group work skills **Teacher/learner focus** Open and respectful. Very encouraging, and gives students some responsibility of their learning (however in a very controlled environment). However he restricts their responsibility substantially outside (inc. activities and rule setting). **Behaviour** Management strategies implicitly planned into the lesson. He perceives that he will be unable to manage students learning as adequately outside, than inside, thus limiting the time spent outside. **Disposition** Enthusiastic and open to ideas	Moderate **PD sessions** Attended 3 sessions Activities completed in the PD sessions were more likely to be taught in school. However where activity objectives not clear decreased likelihood to be trialled. Activity guidelines were followed with limited deviation. Tutor modelling at a PD session said to influence practice (for example group work). Although new pedagogical ideas were trialled - rationale was not fully understood. **In-school** Trialling activities (5 out of eight) with range of key stages enables familisation Working with colleague (and student teachers) – trialled lessons simultaneously and reflected on them together. **Other** Tutor visits prompted teaching. Questionable importance of observation notes as never referred to.	Successful The simultaneous in-house training of CASE enables quick engagement with the programme framework. CASE emphasises a limited time should be spent on data collection. Due to Charlie's limited experience of teaching outside - ecological sampling – and it's narrow focus on data collection it results in a limited time spent outside. **Outdoors** Students learn science outside – the context is not limited to the learning of ecology **Group work** Inclusion of group work and rule setting **Cognitive challenge** Cognitive challenge, understood. Rather than a focus on a few cognitive conflicts many are simultaneously introduced **Questioning** Questioning was open and included students across the class. Questions from the activity sheets used. **Scientific observation** Developing learners' scientific observation skills not observed

Charlie Pence Year 2	**Teaching and learning** As Yr 1: no change Group work –increased belief concerning the role of group work. **Science Epistemology** As Yr 1; no change **School science** Lesson focus on developing understanding about the nature of science, followed by conceptual knowledge (observed and articulated) **Professional development** Activities require clear links with NC & clear outcomes for student learning in an achievable timeframe. Should be bottom up (from teachers) rather than top down (from tutors). Working with a colleague enables deeper personal PD **Teaching/learning outside** Offers memorable experience and unique opportunity for science learning. Offers challenge to apply understanding. Everyday and familiar places for science valued. Opening up students understanding to natural world. Less concerned with data collection and more focused on making connections Student more likely to misbehave or become off-task.	Moderate Confidence score '7' to teach final two activities STEBI (high) PSTE 51/60 STOE 36/60 High teacher efficacy for science teaching; lowest PSTE score out of six case study teachers. Strongly disagrees with the statement: I wonder if I have the necessary skills to teach science outside the classroom (STEBI) 'I still worry about some of the less reliable students' (Interview, March 2009) [Inside] 'I feel more comfortable' than outside' (Interview, June 2009) 'We didn't feel that confident about the lesson, and teaching the lesson'. (Interview, June 2009) 'I have always been quite keen on field work. But I actively changed the coursework (Year 13) to do it outdoors because of the sessions' (Interview, June 2009)	Moderate - High **Subject knowledge** Increased teacher efficacy in teaching subjects outside biology and increased ability to find challenge and pitch it at the correct level. An earlier 'rejected' physics activity is responded to in a more positive manner. Very effective open questioning and increased use of own questions. **Flexibility** Increased willingness to experience and adapt activities – through use of local examples and development of different teaching resources. Increased time spent outside – teaching rather than only data collection. Adapts Urban Jungle for Year 10 lesson. **Teacher/learner focus** As Yr 1 Begins to ask students to give a rationale for rules set. Is concerned to ensure that groups are comfortable with who they are working with. However more teacher-led when outside (see below). **Behaviour** Very good student management skills. Inside behaviour manage is implicit, outside this is not the case. Outside choices seem directed by 'fear' that students will misbehave. Concerned that colleagues will observe class misbehaviour. **Disposition** As Yr 1	High **PD sessions** Attended 2 sessions (not no. 4) Values the authenticity of the PD programme (teachers' role of evaluating and feedback into redesign) and was primary reason for continued involvement. Discursive nature of sessions valued and appreciates how teachers' opinions are valued. Aspects from the PD sessions – (outdoor management strategies (PD3) and group work development (PD1)) are observed to good effect in Year 2. Trialling the activity and reflecting on their outcomes **In-school** Frequently adapted the original lesson activities and changed lesson objectives. Increased importance of working with colleague on programme – importance due to her experience and also her position within the department that directs others in the department to use the activities. **Other** Visits from tutors stimulated action to trail a new activity. The intention to discuss the worthwhileness of the activity rather than his teaching. The research interviews acted in Year 2 as a reflection tool on practice. Able to reflect on CASE PD (Year 1) and outdoor PD programme. Did not keep journal.	Very successful **Outdoors** Teachers outside, rather than students' only collecting data. Uses the environment as a stimulus for discussion. Organises students outside to enable him to teach in the context **Group work** The role of group work increased in importance. The inclusion of pedagogy to ensure students had time to reflect on their learning was planned. **Cognitive challenge** The outdoors as a place to offer cognitive conflict and real challenge was exploited (inc. the use with Year 13 **Questioning** Effective open questions were used - often not arising from the original activity sheet. Open questioning observed outside, involving the 'real life' example with small groups and whole class **Scientific observation** No inclusion of the development of scientific observation skills

Michael Bison Year 1	**Teaching and learning** Traditional/ teacher-led approach Extensive non-interactive/authoritive teaching **Science epistemology** Realist Deductive approach Partially 'Popperian', however no hypothesis building observed **School science** Focus on content knowledge. Students should be told concepts and then observe them. Examination dominance **Professional development** Receiving resources: Involves 'new' activities. Working through activities **Teaching outside** Offers variety: for fun (for him and the students) Some increase in behaviour management required	High A mean confidence score of '6.75' to teach activities. Rates himself 9 for two activities. (His low rating of 3 – for Materials – significantly decreasing mean).	Moderate - Low **Subject knowledge** Comfortable to trial 4 activities across range of sciences. Repetition of physics activity (rose tinted). Basic biological knowledge seen. Closed questioning frequently used. Prone to answering own questions asked **Flexibility** Attends all sessions -passive engagement Attempts 4 from 8 activities. Used only with KS3 classes– ideas not incorporated more widely into teaching Pedagogical issues (such as group work) not seen explicit in observation Has thought about other outdoor ideas (but not yet implemented) **Teacher/learner focus** Teacher rather than learner focused. Examination focused. No ownership on learning given to students No acknowledgement of particular student needs **Behaviour** Challenging behaviour accepted (expected?), almost submissive **Disposition** Apathetic: getting through it/ getting by	Moderate 'Surface engagement' **PD sessions** Attended all 3 sessions Evident on the evaluations - 'Most confident' to teach activities lead through by tutors. However where confusion arises concerning an activity objective, activity was avoided Notes, going through the activity was of great importance to teaching it. Trials lesson where props were presented. Also trialled lesson where there was an obvious resource attached (egg box, glasses) Did not trial any lesson which necessitated read-through only Teacher presentation – activity retrieved 'red and green on board' Limited engagement with 'pedagogical ideas' Limited interaction with other teachers **In-school** Trialled activities No colleague – all teachers too busy No formal meeting Informal conversation – colleagues have been interested when they have seen students outside with coloured glasses **Other** Observations unsure if read as not commented on. Research interview where cognitive challenge explained	Moderately successful - unsuccessful **Outdoors** Students are brought outside **Group work** Limited group work: brought on student tour Rules setting – students encouraged but this was individually and then shared with whole class **Cognitive challenge** Cognitive challenge, was not understood and was not observed **Questioning** Questioning predominantly closed. Of the form I-R-E. When good questions were asked, which were created by himself rather than arising from the sheet he tended to answer them himself. Able to prompt, but limited thinking time or group discussion. Overly concerned about the resourcing of questioning (for example mini-whiteboards) rather than the principle **Scientific observation** Developing scientific observation not observed

Michael Bison Year 2	**Teaching and learning** As Year 1 Observed incorporating group work into practice (which might infer a move towards social constructivism) however action is more concerned with the activity of doing 'group work' apparent in the lack of time given to student reflection and reasoning **Science epistemology** As Year one **School science** As Year one however He does articulate the importance of 'skills' but was not observed in practice **Professional development** PD mainly occurs in practice – in the classroom He articulates that PD is through talking to colleagues in and outside school – however this was not witnessed in his practice. PD should be delivered – although in contradiction to the first belief. Involves 'new' activities. **Teaching outside** As year one Offers link between classroom science and outdoors Some increase in behaviour management required	High – moderate Confidence of '9' for final two activities (although never uses them) STEBI (v high) 56/60 (PTSE) 42/60 (STOE)	Moderate - Low **Subject knowledge** Trials few lessons, remains focused on rose tinted. P/point developed: all resources used from PD sessions Questioning as Year one. General lack of challenge in objective and questions Subject knowledge of biology questionable **Flexibility** Attends 2 out of 3 sessions Repeats rose tinted and 'urban jungle' only Didactic teaching in and outside Does not work with mathematics teacher to develop ideas Remains attached to 'what they need to know' Talks again about extending ideas (website) but not put into action **Teacher learner/ focus** As Year one Acts as a guide Noted to be critical of students Names are not used often (aloof) Group work outside however no focus on developing group work skills **Behaviour** As Year one Notes that he is not the 'master of behavioural management' **Disposition** As Year one Questionable planning Talks about his ideas but not seen in practice	Low **PD Sessions** Attended 2 sessions (not no. 6) Resources taken directly from PD session (from Year 1, e.g. photos) Activity sheets used "Other teacher ideas" – inc. setting boundaries (group mgn ideas) Tutor ideas' – group work rule setting (partially implemented); practice implemented but underpinning theory was not observed 'Observation' ideas not taken forward (even though discussed twice) No attempt to develop own ideas (even though a explicit focus during PD-session 4) **In-school** Only completed two activities (rose tinted and urban jungle) As above **Other** Emailing to observe an activity, prompts trialling of activities Did not keep journal.	Unsuccessful **Outdoors** Limited attempt to go outside (twice but only following prompting from researcher) **Group work** Student asked to take roles (scribe, equipment holder etc.); students were not prompted to reflect on reason or nature of role. Students did not consider how it might be group work might be improved **Cognitive challenge** Talks about the concept as 'hook' to get students interested. Says that students will solve the challenge by drawing on the knowledge relayed to them at the start inside the classroom **Questioning** Open questions taken directly from the lesson activity. Student asked to work in groups to discuss their answers. First direct evidence of PD pedagogy in practice. Quickly reverted to teacher –led. More aware of the form of questioning. Some scepticism sensed about the necessity of questioning **Scientific observation** Does not engage with developing scientific observation. He does not remember PD session when it was discussed.

Claire Westwood Year 1	**Teaching and learning** Social constructivist approach: a distinct focus on the collaborative group Dominance of dialogic/interactive & dialogic/non-interactive teaching: student-led Incremental theory of intelligence. **Science epistemology** More than one-way of understanding the world. The importance of 'having scientific ability to understand the world' - 'interpretist' position. **School science** Making predictions was important Development of scientific skills essential. Application of science knowledge important – rather than theory alone. **Professional development** Reflecting on practice to become conscious of what you do and why you do it. Talk and share ideas with other teachers and colleagues. Time to trial activities in the role of the student important. **Teaching outside** Enables students to become more aware of own surroundings. Opportunity for students to find their own interests. Enables students to see things in a different way. Students need to be taught and to learn outside it takes time.Students are distracted easily outside.	Moderate - high A mean confidence score of '6.5' to teach activities. Majority range between scores of 6-9: Materials (3) and Air pollution (5).	Moderate -high **Subject knowledge** Comfortable to trial activities outside subject specialism. However believes that she has fewer skills in using the outdoors when compared to biology teachers, as she is a chemist. Very at ease with asking open questions across all activities. **Flexibility** Trials arrange of activities (5/8) across a range of KS3 classes. Very focused on teaching skills such as group work and observation – sees the benefits. Incorporated the outdoors into several other lessons. Feels confident once students understand how to work outside. Supports other teachers to trial activities. Time limited to data collection when outside. Suggests using an alternative classroom as a base to ease travelling to and from outdoor space. **Teacher learner/ focus** Focus was on the learner. Group work was encouraged; however no time was given to students for reflection on learning. Questioning was supportive. Some responsible given to students outside – however in the main it was limited to data collection. **Behaviour** Generally activities chosen for learning purpose. Multiple opportunities for cognitive challenge offered. However when outside strategies often chosen due to behaviour management. **Disposition** Enthusiastic. Very willing to trial new ideas.	High **PD sessions** Attended all PD sessions Modelled activities in role of student (to enable insight of how a student approaches things) Limited attempt of activities that were read through only. Importance of the status of the tutors. Sharing ideas with colleagues at session both formally and informally. Valued discussion Reflecting back on activities already completed. **In school** Working with colleague on programme – at session and in-school very important. Trialled range of activities. Encouraged student teachers to trial activities **Other** Being visited by external evaluator (and tutors) gave the PD status and added urgency to trialling activities. Attended CA conference and contributed to a workshop run by the tutors about the PD programme. (March 2008)	Successful **Outdoors** Prior to the PD Claire rarely considered using the outdoors and felt it was related to biology topics. At the end of Year 1 she has taught many activities outside. **Group work** Claire was comfortable to include group work in her practice. She asked students to develop their own rules for good group work. She acknowledged that organising group work outside presented different challenges than inside. **Cognitive challenge** The outdoors was seen as a terrific context for cognitive conflict. Students' finding their own examples and being challenged to explain the scientific concept was embraced. Open questioning to elicit their understanding was skilfully used. Originally several activities due to their openness caused concern – however specificity in the challenge was eventually identified. **Questioning** Very effective open questioning with some 'starter' questions drawn from the original activity. However in the main Claire was very skilled in prompting students and supporting them to develop their answers. No whole class questioning outside. **Scientific observation** Observation skills not explicitly taught.

Claire Westwood Year 2	**Teaching and learning** As year one **Science epistemology** As year one **School science** As year one, however focus seemed more pronounced on scientific skills and 'learning-to-learn' skill development e.g. group work; listening to one another **Professional development** As year one To reflect on practice, increase teaching repertoire to include: physical activities, ideas, pedagogy skills and management strategies. **Teaching outside** Encourages longer discussion due to real life examples. Encourages high and low attaining to join in – the environment encourages all students. Encourages group work Apply understanding of science to their real world. The outdoors is not only restricted to the teaching of biology. Necessitates a higher amount of planning	High Confidence of '8' for final two activities STEBI (high) 53/60 (PTSE) 34/60 (STOE) Joint lowest STOE score with Cara	High **Subject knowledge** Trialled 7 of the activities during Year 2 across KS3 classes and Year 10. Confidence to teach Urban Jungle lesson to Year 10 students arose from colleague who was a biologist (Charlie), who trialled and adapted it originally for specification. Very effective open questioning seen in and outside the classroom. However limited whole group teaching outside – alternative strategy put in place (see below). **Flexibility** Arranged a programme for colleagues to teach three of the activities with Year 9 classes. Following her own suggestion in Year 1 she organises to move her classes to a room with easy access to outdoor space for these lessons. The indoor space has no tables/ chairs and therefore students sit on the floor in groups. This arrangement is a compromise between teaching the student as a whole class outside. **Teacher learner/ focus** Focus is on the learners. It is very personable and encouraging. Students are asked to reflect on group work at the start and at the end of the lessons. Students are asked to reflect on 'rules' during activities where necessary. **Behaviour** Very good management skills. An underlying concern that students will be disruptive to others when going outside remained apparent. Hence the use of the indoor space with direct access enabled groups to be gathered swiftly inside – however no outdoor whole group discussion observed. **Disposition** As year one	Very high **PD sessions** Attended 2 PD sessions (not PD4) Modelling activities essential: Ideas from sessions in Year 1 are observed to be repeated in-school during Year 2. Explicit curriculum links valued as they trigger initial attempt to trial lesson. Several lessons not originally trialled in Year 1 are attempted. The duration of the PD was valued as was the consistency of meeting the same teachers over the two-years. Greatly values the time to reflect on practice, to think about aspects from the PD already within your practice and areas that require development. Activities need clear curriculum links for initial engagement. **In-school** Working with colleagues – highly valued (as Year 1) for discussion; to clarify understanding of PD; to hear ideas from a different perspective; to develop lesson ideas; to reflect and to encourage to trial new ideas, especially at KS4 in biology. No formal department INSET run. Materials and framework discussed briefly at departmental meeting. Resources shared in departmental computer portal. Year 9 teachers timetabled to teach three of the lessons during May. Relocated classrooms to enable easier access to outdoors. **Other** Attended an ASE regional conference and contributed to a session run by the tutors about the PD programme (June 2009). Creating resources important. Did not keep journal.	Very successful **Outdoors** At the end of the programme Claire felt that using the outdoors was now a pedagogical choice which previously she would not have considered. She understood that students need to be prepared for learning outside and that skills had to be consciously planned into lessons and made explicit. **Group work** Claire refined her group work pedagogy by the inclusion of reflection time of group rules and individual learning. Claire became aware that groups needed to operate in a different manner in the outdoors and students needed time to adapt their learning **Cognitive challenge** As Year 1 the outdoors was felt to present good opportunities for challenge. Due to familiarity with the activities Claire was felt to be more able to respond to 'new examples' and focus the challenge. Whole class discussion focusing on cognitive challenge was never undertaken outside. Claire planned the lesson so that she was able to use a classroom with outdoor access so that she could easily bring students inside. Therefore no whole class discussion took place using *in situ* examples. **Questioning** As year one. **Scientific observation** Claire used the observation activities within stand-alone skill development lessons. She was also observed asking individual students to make observations and then prompting students to extend their responses.

Cara Brown Year 1	**Teaching and learning** Social constructivist approach. Student discussion valued. Believes students learn best when they have ownership of task. Also when teachers are enthusiastic. Dialogic/interactive teaching practice dominated. **Science epistemology** Science 'explains so much of what is happening'. Predominantly relativist. **School science** Application of knowledge important. Develop of students' social skills. **Professional development** To develop individual teaching practice. Achieved through: InSET and colleague observations. **Teaching outside** Fun. Generally important to encourage students to think about outdoor space, observe different organisms and 'real life' examples. Generally become more aware of local environment. Memorable offering cognitive hooks. Poor student behaviour will result on leaving classroom and working outside. Gaining the necessary support from additional staff challenging. Need to develop good group work skills in students.	Moderate-low Confidence rating of '6.8' to teach activities The range was 6-8. Notes feeling uncomfortable bringing students outside due to unpredictability of behaviour, her ability to manage and their potential for disruption of other classes. 'I felt very wary about going from inside to outside' (Interview, June 2008).	Moderate -low **Subject knowledge** Attempts four activities with two KS3 classes. Used open-questions – majority from activity sheet. Gives students thinking time before answering questions. Limited use of examples from the outdoors into lesson. Time outside very limited. **Flexibility** Attends all PD sessions. Adds to group discussions – and is open with her reflections. Attempts a limited range of activities with two classes only. Activities trialled only when they can be incorporated into the teaching sequence. Does trial with a 'challenging' class. Observed incorporating some aspect of group work e.g. consideration of members in a group. However skills of rule setting and reflecting on practice not incorporated. Was stressed prior to observation about potential difficulties to access selected outdoor space (leaves voice mail and emails). Adapted Egg box activity to make it more 'biological'. Incorporated 'Forces' into SoW for following year. Extended Urban Jungle into a lesson sequence. **Teacher/ learner focus** A mixture of foci was apparent. Time is made available to students to think, discuss in groups and feedback. However teacher dominance is seen in presenting group rules. **Behaviour** Although in the main fears concerning behaviour management dominate pedagogical decisions e.g. time outside, dictating group rules, there was an effort to include pedagogy, such as group work skills, to enable student control. **Disposition** Enthusiastic. Fearful of behavioural issues.	Moderate **PD sessions** Attended three PD sessions (leaving early PD3) Trialling activities, taking the role of the student, greatly valued. Values the task of evaluating activities so that changes can be made. Values discussions with colleagues from other schools. Also appreciates the consistency of meeting the same individuals. Tutor ideas for group work and related practices noted as beneficial. As are question stems, to be used for students to write their own questions. Activity sheets and related resources (for example key questions from sheets and photographs) –noted to be used in school. **In-school** Second member of staff not permitted to join. The reason given was financial and time restraints. HoS informally was actively involved. She was in SLT. Materials were shared with NQT who she mentored. NQT observed outdoor lesson and was encouraged to trial it. Formal 5 minute feedback to department on activity given. No further feedback on PD was given. **Other** Journal was used to record reflections following lesson. The journal was seen as a link between PD sessions and encouraged her to trial activities.	Moderately successful **Outdoors** Two classes used the outdoors in science lessons – the context is not limited to learning ecology. Limiting teaching outside – used mainly for data collection. **Group work** Focused on the allocation of roles rather than the development of student group working skills. **Cognitive challenge** Cognitive challenge understood in terms of something the students needed to work out and should not be given away by the teacher ('as was often done so in other lessons'). **Questioning** Questioning open and included students across the class. Questions often drawn from activity sheet. Noted as a method of AfL **Scientific observation** Developing learners' scientific observation skills not observed.

Cara Brown Year 2	**Teaching and learning** As year one **Science epistemology** As year one **School science** As year one **Professional development** As year one. To achieve personal development targets. To develop methods of communication with students. External PD essential for government strategy implementation (such as APP). **Teaching outside** Enhances teaching, making it more interesting and exciting. Making studying more relevant. Enables abstract ideas to become more tangible for students. Consolidation of taught materials. Enables student freedom. Teacher's role was facilitator. Increased planning. Poor student behaviour. Weather can cause problems. Possible lack of good enough examples for students to find. Time restrictive. Necessity of support staff.	Moderate No evaluation of final activities. STEBI (high) 53/60 (PTSE) 34/60 (STOE) Joint lowest STOE score with Claire Feels more comfortable working outside however potential behavioural issues are still a deterrent to working outside more often.	Moderate-low **Subject knowledge** Retrials Forces and Eggbox. Does not attempt any other activities. **Flexibility** Does not attend any PD sessions during Year 2. Does not trial any additional activities and there is no attempt to use with different Year groups. Describes herself as a facilitator outside whereby the teaching remains inside the classroom. New KS3 SoW includes two outdoor activities. Outdoors is used in a lesson on 'stunts' (forces) where previously it had not been. Group work skill development was incorporated into Yr7 SoW. **Teacher learner/ focus** Not able to judge due to no lesson observed. **Behaviour** Number of outdoor lessons limited due to potential threat of behavioural issues. **Disposition** A feeling of resentment towards the SLT for their lack of support.	Low **PD sessions** Absent from all PD sessions **In-school** Two outdoor activities placed into new KS3 SoW. HoD left at end of Year 1. She had originally encouraged department participation. Nearside had an Ofsted inspection at the end of Year 1 resulting in new whole-school targets and revised staff PD policy. PD had to be directly linked to individual's performance management review. These were carried out termly. Staff's PD was structured around school targets. However they were allowed one personal target. Internal PD was encouraged and external training had to be applied for two terms in advance. This was limited due to 'rarely cover' and finance. **Other** None	No observations

Megan Thomas Year 1	**Teaching and learning** Social constructivist. Dominance of Interactive/authoritative and Interactive/dialogic teaching approach **Science epistemology** Any claim can be made if appropriate evidence is provided. Positioning her as 'interpretist' **School science** Necessary to develop essential skills for life: analytical, evaluation, group work. To understand how the world functions and interacts. **Professional development** Values: Trialling activities, discussion with colleagues on their experiences, external tutors observation **Teaching outside** Encourages greater group discussions. A broader number of topics can be integrated simultaneously. Teaching is less rigid.	High Mean confidence of '7.25' to teach the activities. Score was joint highest with Charlie. Two activities rated '9'. Asks for a tutor visit to enable reflection on lessons (Session evaluation, Oct 2007) Keen to share reflections of practice in a presentation session March 2008	High **Subject knowledge** Attempts a wide range of activities across all year groups inc. Year 12 and 13. Uses open questions, often from the activity sheet. Remains outside during whole class questioning so that students are able to refer to examples *in situ*. **Flexibility** Attends and engages in all the PD sessions. She leads a discussion on managing students outside by presenting her reflections during PD2. Discussed the explicit development of group work skills with her students. Ease of transition of teaching practice from inside to outside. **Teacher learner/ focus** Focused on the learner. Group work has been thoughtfully designed to ensure that all students have to listen and talk. Is aware of utilising student strengths in groups. A short time is allocated to student reflection on their individual learning. A great amount of time is given to students learning rather than listening to the teacher both inside and outside. **Behaviour** Pedagogical choice dictates behaviour management. Implicit behaviour strategies used both inside and outside. **Disposition** Enthusiastic, realistic, very willing.	High **PD sessions** Attended all PD sessions Highly valued time to trial the activity and observe how it can be successfully taught. Valued: Discussions with colleagues from other schools on aspects of implementation; the activity being ready to trial with all resources available; the activity being 'quite self explanatory' Gave short presentation of ideas during PD session. **In school** Trialled all the activities (except Air pollution) On trialling the activity felt positive about the students' responses. A colleague was involved until Easter 2008. She had encouraged colleague due to her inexperience of working outside. Gave a short (20 minute) overview of the PD programme to the department. Reviewed several activities and focused on the importance of group work development. Distributed a map highlighting of school grounds highlighting specific areas for interesting projects. Gave a short presentation about the PD programme and how it related to students attitudes towards the environment (a focus of her MA) during a whole school InSET. **Other** Values PD tutors observing lessons. Felt it motivated greater reflection on lessons. Completed her MA Science Education dissertation on student attitudes towards the local environment following exposure to the outdoor activities.	Very successful **Outdoors** Teaching outside necessitated different strategies. It was felt to encourage greater group discussion, increased topic coverage and lessons were felt to be less rigid. She was observed developing new management strategies outside (for example giving out stop clocks for time keeping, standing on a step to be seen). Similarly she was seen to transfer strategies, such as questioning, from the classroom with ease. **Group work** Although the importance of group work is noted, there seems to be limited explicit evidence in her practice to develop these skills in her students. Students do work in small groups and roles are outlined. **Cognitive challenge** Megan believes that students learn through challenge. She identifies that initially setting up a challenge and giving the students space to think without interrupting them originally feels foreign. Whilst students are working outside she interacts with them through a series of exploratory questions. **Questioning** Open questioning is used very effectively. Many of the starter questions displayed on the board are taken directly from the sheet. Questioning in whole class situations is Interactive/authoritative in nature. When seen questioning small groups it is Interactive/dialogic in nature. **Scientific observation** Observed encouraging students outside to record observations. Uses classification keys in her lessons.

Megan Thomas Year 2	**Teaching and learning** As year one **Science epistemology** As year one **School science** As year one **Professional development** Should offer something new for teaching practice. Values relevance to SoW. **Teaching outside** Raises the profile of the outdoor environment. Demonstrates that the outdoors is not exclusive to ecology topics. Encourages students to see science in the familiar outdoor contexts. Teachers need to develop the necessary skills in students to work outside appropriately. Students need to be become familiar to be able to become confident in learning outside. Access to interesting grounds makes it less challenging.	High '9' for final two activities. STEBI (v high) 58/60 (PTSE) 42/60 (STOE) Highest overall STEBI Notes how comfortable she is to bring students outside due to no concerns for behavioural issues. Following trialling activities at PD sessions she comments: 'you feel that much more confident – "oh that's what you do, oh that's easy I can do that" – and then you start and get better and better'. (Interview, April 2009) Evidence of lack of confidence: 1)Questions her qualifications to become CASE 'expert' in the department. 2) Highlighting that although she feels able to ask open questions believes that she still has improvements to make.	High **Subject knowledge** Trialled all the activities on numerous occasions across all age groups. Adapted the activities to enable the lesson to become more specific to the students ability. High level of subject knowledge that enabled a high frequency of real life examples to be used. Open-ended questions used. **Flexibility** Attends 2 PD sessions and for the PD missed asks for notes of which she is observed to implement. Teaches explicit scientific observation skills across a range of classes. Develops all the activities so that they can be integrated into SoW. **Teacher learner/ focus** As year one. Students observed to be given great autonomy of their learning through an outdoor investigation leading to *in situ* presentations of findings. Students encouraged to give feedback to others. **Behaviour** As year one. Acknowledges that if students were likely to misbehave it would be more 'scary' to bring them outside. **Disposition** As year one.	Very high **PD sessions** Attended two PD sessions (absent PD6) Valued the transferable pedagogical framework used for all activities (discussed in PD4). Values the transferability of all the activities to the SoW. **In school** Trialled all the activities on multiple occasions across multiple classes. Encouraged student teacher to teach the activity on two occasions. Lead an extended departmental InSET on the PD programme (30 minutes). Used PD tutor's presentation resources for the sessions. Colleagues within the department observed her teaching several outdoor lessons. All department colleagues trialled several activities. Activities have been placed into KS3 SoW (except Air pollution). **Other** Funding important: to enable release from school. Did not keep journal.	Very successful **Outdoors** Note worthy is Megan's holistic impression of the project objectives: 'Getting pupils' comfortable and confident outdoors in groups and discussion, raising the profile of their outdoor environment and, demonstrating to staff that going outside is not just about ecology (PD4 Evaluation/reflection sheet). Outside she appeared relaxed. Except for the starter, all parts of lessons are observed outside: including discussion, plenary and reflection. **Group work** Students list their own group rules. These are recorded and students observed reviewing rules from previous lessons. Megan believes that attention to group work skills was essential for successful learning outside due to the requirement that students manage their own behaviour and learning (compared to inside). **Cognitive challenge** She appreciates that teachers' might find the unknowingness of the items students might use outside as daunting. She is observed at ease at introducing the challenge and encouraging students to find their own answers. **Questioning** Frequently teachers observe Megan's lessons to develop their own questioning skills. Megan says it is an area that you can never be perfect in. Her practice as Year 1. **Scientific observation** Encourages students to extend their observation descriptions in her Q & A sessions. Adapted and used the observation activities with all year groups (inc. A-level).

Tom Peterson Year 1	**Teaching and learning** Predominantly traditional (teacher-led) teaching approach Dominant interactive/authoritive **Science epistemology** Realist **School science** Required to develop student scientific skills and to form future scientists. **Professional development** Values: Discussion with teachers from other schools Activities directed related to SoW and new ideas **Teaching outside** Novel and offered freedom to students. More engaging than inside the classroom	Moderate Mean confidence score of '6.5' to teach four from a possible eight activities (no data from session 1 as form incomplete). Confidence rated as '3' for Rose tinted and '9' for Urban jungle activity.	Moderate **Subject knowledge** Trials four activities across a range of sciences. Repetition of general science related activity (Egg box). Trials rose tinted on several occasions, even though he scored his confidence as '3' directly after the PD session. Unchallenging physics lessons observed (forces activity). Questioning was frequently closed in nature and reflected the pattern I-R-E. **Flexibility** Attends all PD sessions. Relatively engaged. Attempts four from eight activities across three classes. Uses filter glasses often as a classroom activity. Observation skills not taught. Group work skills considered important but not explicitly developed in students. Pedagogy from inside not transferred outside. Develop several new outdoor management techniques: boundary setting, gaining attention. Used park instead of using play ground to increase novelty and range of examples. Plans a maths/science day during summer term which is all outside and includes one of the programme's activities. **Teacher learner/ focus** Lesson is planned from the teacher's perspective. However when some of the activities result in giving students more control (than in a normal lesson) he was surprised and impressed by how able the students were in making links from different concepts in science to different examples. He was also impressed by how able students were to give extended scientific explanations. **Behaviour** Limited consideration of pedagogy to use outside compared to inside. Some consideration of student management – invisible boundaries set and a 'meeting' point – however limited consideration. **Disposition** Initial enthusiasm and some willingness try new ideas.	Moderate **PD sessions** Attended all PD sessions Liked to discuss ideas with colleagues from other schools. Activities modelled by tutors only trialled in school. Other pedagogical aspects e.g. group work, observation not engaged with. Ideas presented by the teacher on behaviour management (for example boundary setting) were observed. **In-school** Trialled four activities, partial use of framework. Resources from PD used inc. egg-boxes, adapted PowerPoint, filter glasses. Initially worked with colleague who also attended the PD quite closely. She was more motivated but apprehensive of behavioural issues. They visited the park prior to the lesson together and he companied her class on her first visit. Informally colleagues found out about the PD activities – by seeing students outside or with glasses. Hence colleagues borrowed equipment. **Other** Financial support from project enabled day release. HoD directing him onto programme.	Moderately successful **Outdoors** Three year groups were brought outside. School grounds and local park were used. Several different outdoor management techniques used. Mainly the use of the outdoors was restricted to data collection. Tom saw himself as a facilitator. **Group work** Tom noted the importance, as well as the challenge, in student group work. He said that he put students into 'outdoor' groups to work (how these were decided was not disclosed). However group rules were set on a superficial level, as was the reflection on learning towards the end of the lesson. **Cognitive challenge** To some extent the challenge was removed by presenting the theory too readily at the beginning and offering limited challenge in the lesson objectives. **Questioning** Closed questioning. In the form I-R-E. **Scientific observation** Developing students' observation skills was not observed.

Tom Peterson Year 2	**Teaching and learning** See year one **Science epistemology** See year one **School science** See year one **Professional development** Valued: As year one The duration of the PD – unique Working with colleague within school **Teaching outside** Linked classroom science to the real world. 'Treat' for students. Offers enjoyment in science and new ways to teach. Outside demands less of teaching: more facilitation. School (during Year 2) increased administrative requirements to bring students to the park (forms, insurance, staffing). Considered too time demanding. More things can go wrong outside and there is less access to a back-up	Moderate Absent from PD4 so no data of confidence for final activities. STEBI (high) 54/60 (PTSE) 41/60 (STOE) On being asked what skills he had developed through the programme he responds: 'More confidence about going outside with a whole group of pupils'. (Reflections , Session4) He says 'by having more experience in teaching generally and therefore having more exposure to different ideas increases confidence.' Feels less comfortable outside than in, 'because if you think you are going to lose control anything could happen'. 'It is a bit more work and there are more things that can go wrong, and you are not in your safety zone..[…] you are outside and you've got less back-ups and there are more things that can happen'. (Interview, July 2009)	Moderate-low **Subject knowledge** No activities trialled. **Flexibility** Notes that 'forward planning activities' was a skill he had developed from the programme. However does not trial any activities due to 'staffing issues', which lead him to have to set cover for absent colleagues, the necessity to have more than one member of staff with classes and the time to complete necessary paper work (and to get insurance). Did use park for science club. **Teacher learner/ focus** As Year 1 Admits 'in the classroom you are in control, you are the boss, and then outside it's as if you become just like a site manager' (Interview, July 2009). **Behaviour** Concerned about student behaviour: 'because if you think you are going to lose control anything could happen'. 'It is a bit more work and there are more things that can go wrong, and you are not in your safety zone..[…] you are outside and you've got less back-ups and there are more things that can happen'. (Interview, July 2009) **Disposition** In theory, enthusiastic to teach outside however considers the number of external factors too constraining.	Low **PD sessions** Attended PD4 only Although 'scientific observation' was focused on during PD4 he does not remember the session or the activities at the end of the year. **In-school** Trials no activities. Colleague does not continue with PD programme and does not use activities with her classes. No further discussion of PD with colleagues. No interest at school level. **Other** Did not keep journal.	No observation

Appendix 22 Case study teachers' beliefs concerning learning outside for Year 1 and 2

Teachers	Beliefs about **learning** outside Year 1	Beliefs about **learning** outside Year 2	Programme implementation Year 1; Year 2	Programme Engagement Year 1; Year 2
Megan Thomas	Encourages greater group discussions. Opportunities for topic integration. Increased flexibility.	Raises the profile of the outdoor environment. Demonstrates that the outdoors is not exclusive to ecology topics. Encourages students to see science in the familiar outdoor contexts.	Very successful; Very successful	High; Very high
Claire Westwood	Enables students to become more aware of own surroundings. Opportunity for students to find their own interests. Enables students to see things in a different way.	Encourages longer discussion due to real life examples. Encourages more and less able to join in – different environment encourages all students. Encourages group work Apply understanding of science to their real world. The outdoors is not only restricted to the teaching of biology (which was originally felt).	Successful; Very successful	High; Very high
Charlie Pence	Pedagogical variety; novelty; excitement. Visual aids. Outside is a source of data collection only	Offers memorable experience. Offers a unique opportunity for science learning. Offers challenge to apply understanding. Everyday and familiar places for science valued. Opening students understanding to natural world. Becomes less about	Successful; Very successful	Moderate; High

		data collection and more about making connections		
Michael Bison	Offers variety: for fun (for him and the students)	As year one Offers link between classroom science and outdoors	Moderately successful/ unsuccessful; Unsuccessful	Moderate; Low
Cara Brown	Fun. Generally important to encourage students to think about outdoor space, observe different organisms and 'real life' examples. Generally become more aware of local environment. Memorable offering cognitive hooks.	Enhances teaching, making it more interesting and exciting. Making studying more relevant. Enables abstract ideas to become more tangible for students. Consolidation of taught materials. Enables student freedom.	Moderately successful; No observation	Moderate; Low
Tom Peterson	Novel Offered freedom to students. More engaging than inside the classroom	Linked classroom science to the real world. It was a 'treat' for students. Offers enjoyment in science. Offers new ways to teach. Outside demands less of teaching more on facilitation.	Moderately successful; No observation	Moderate; Low

*Based on Table 6-2 and Appendix 21 Summary of case study teachers

Appendix 23 Case study teachers' beliefs concerning teaching outside for Year 1 and 2

Teachers	Beliefs about **teaching** outside Year 1	Beliefs about **teaching** outside Year 2	Programme implementation Year 1; Year 2	Programme engagement Year 1; Year 2
Megan Thomas	Increased flexibility.	Teachers need to develop the necessary skills in students to work outside appropriately. Students need to be become familiar to be able to become confident in learning outside. Access to interesting grounds makes it less challenging.	Very successful; Very successful	High; Very high
Claire Westwood	Students do not know 'how to' learn outside. Need to be taught and takes time. Students are distracted easily outside.	Necessitates a higher amount of planning.	Successful; Very successful	High; Very high
Charlie Pence	Student more likely to misbehave or become off-task. Outside is a source of data collection only.	Student more likely to misbehave or become off-task.	Successful; Very successful	Moderate; High
Michael Bison	Some increase in behaviour management required.	Some increase in behaviour management required.	Moderately successful/ unsuccessful; Unsuccessful	Moderate; Low
Cara Brown	Poor student behaviour will result on leaving classroom and working outside. Gaining the	Increased planning. Poor student behaviour. Weather can cause problems. Possible lack of good enough	Moderately successful; No observation	Moderate; Low

	necessary support from additional staff challenging. Need to develop good group work skills in students.	examples for students to find. Time is restrictive. Necessity of support staff.		
Tom Peterson	Novel and offered freedom to students. More engaging than inside the classroom	School (in Year 2) demanded teacher completed a lot more administrative duties to bring a class to the park (forms, insurance, staffing). Previously this had not been the case. This was felt to necessitate too much time too bother. More things can go wrong outside and there is less access to a back-up.	Moderately successful; No observation	Moderate; Low

Appendix 24 Comparison of science specialism, science epistemology and school science

Teachers	Subject specialism (degree or A-level specialism)	Science epistemology The teacher believed...	Beliefs about school science content Students' needed…
Megan Thomas	Biology	any claim can be made if appropriate evidence is provided. Held an 'interpretist' position.	to develop essential skills for life: analytical, evaluation, group work; to understand how the world functions and interacts.
Claire Westwood	Chemistry	there is more than one-way of understanding the world. Held an 'interpretist' position.	to make predictions; to develop scientific skills, as the application of science knowledge is important – rather than theory alone.
Charlie Pence	Biology	there is more than one-way of understanding the world. Held an 'interpretist' position.	to understand science content knowledge; to understand how science is 'made'.
Michael Bison	Physics	in a Deductive approach. Held a Realist position.	to understand science content knowledge; to pass examinations.
Cara Brown	Biology	science 'explains so much of what is happening'. Predominantly relativist.	to understand scientific application; to develop social skills.
Tom Peterson	Chemistry	Realist position.	to develop scientific skills; to form future scientists.

Appendix 25 Programme strategies influential on case study teachers

Programme context	Strategy/Factor	Megan Thomas		Claire Westwood		CharliePence		Cara Brown		Tom Peterson		Michael Bison	
	Year commented on/observed	1	2	1	2	1	2	1	2	1	2	1	2
	Sessions attended	3	2	3	2	3	2	3	0	3	1	3	2
Session *(Focus on whole activity)*	Activities 'acted out' – tutor led	x	x	x	x	x	x	x	x	x	x	x	x
	Activity read through and 'props' presented				x								
	Group discussion and evaluation of an activity	x		x	x	x	x	x	x	x			
	Activity developed within a group			x	x			x					
	Receipt of activity props/resources	x		x		x		x	x	x			x
	Receipt of activity lesson plan: clear obj/NC links		x		x	x	x				x		
	Sequence of sessions with follow-up/review				x		x		x		x		
	Authenticity of programme - theory and tutors			x			x						
	Clear pedagogical framework - transferable to other lessons		x			x							
Session *(Focus on specific aspects of pedagogy framework)*	Aspect: Observation *A tutor-led activity to develop teaching observation skills to students*	x	x		x								
	A teacher-led activity to develop student observation			x								x	
	Aspect: Group work Theoretical ideas presented on group work							x					
	Aspect: Cognitive conflict (CC) An activity to identify the CC in the lesson activities through discussion												
	Aspect: Questioning Writing questions for the activities with the support of 'question							x					

	stems'												
Session (Focus on student management)	Strategies to manage students outside presented by a participating teacher	x					x	x		x		x	
	Strategies to manage students outside shared in groups						x						
	Strategies to manage students outside presented by tutor during activity teaching						x						x
In school	Generally trialling activities	x	x	x	x	x	x	x		x		x	x
	Trialling and adapting activities with a range of classes	x			x	x	x	x		x			
	Sharing ideas with a colleague/student teacher	x	x	x	x	x	x	x		x			
	Observing newly qualified teacehr/student teacher trial lessons		x	x	x	x	x	x					
	Sharing activities with department: formally/informally	x	x	x	x								
Other	Reflecting in journal							x					
	Through lesson observation/feedback from programme tutor	x		x		x	x						
	Through research interviews						x					x	
	Presenting at conferences		x	x	x								
	Completing a research study (M-level)	x											
	Financial support from college		x							x			

(Data sources: Interviews, lesson observations and session field notes)

Appendix 26 Programme strategies identified as source of teacher efficacy

Programme context	Strategy	Source of Teacher Efficacy
Session (Focus on whole activity)	Activities 'acted out' – tutor –led simulated modelling	Cognitive mastery experience Vicarious experiences
	Activity read through and 'props' presented	Verbal persuasion
	Group discussion and evaluation of an activity	Verbal/social persuasion Emotional/psychological experience
	Activity developed within a group	Verbal /social persuasion Cognitive mastery experience
	Receipt of activity props/resources	Verbal persuasion
	Receipt of activity lesson plan: clear obj/NC links	Verbal persuasion
	Clear pedagogical framework - transferable to other lessons	-----
	Authenticity of programme - theory and tutors	Cognitive mastery experience
	Sequence of sessions with follow-up/review	Cognitive mastery experience
Session (Focus on specific principle of pedagogy framework)	Principle: Observing the local	Cognitive mastery experience
	A tutor-led activity to develop teaching observation skills to students	
	Principle: Collaborative group work	Verbal persuasion Cognitive mastery experience
	Tutor presented theoretical and practical ideas on group work	
	Principle: Provoking challenge	Cognitive Mastery and verbal/social persuasion
	An activity to identify the 'challenge' in the lesson activities through discussion	
	Principle: Learning through questioning	Cognitive mastery experiences
	Writing questions for the activities with the support of 'question stems'	

Session (Focus on student manageme nt)	Strategies to manage students presented by a participating teacher	Verbal persuasion
	Strategies to manage students outside shared in groups	Verbal persuasion
	Strategies to manage students outside presented by tutor during activity teaching	Vicarious experience Cognitive mastery experience
In school	Generally trialling activities	Enactive mastery experience
	Trialling and adapting activities with a range of classes	Enactive and cognitive mastery experience
	Sharing ideas with a colleague	Social/verbal persuasion
	Observing colleague	Vicarious experience
	Through lesson observation/feedback from programme tutor	Social/verbal persuasion
	Sharing activities with department: formally/informally	Cognitive mastery experience Emotional/psychological experience
Other	Reflecting in journal	Emotional/psychological experience
	Through interviews	Emotional/psychological experience
	Presenting at conferences	Cognitive mastery experiences Emotional/psychological experience
	Completing a research study (M-level)	Cognitive mastery experience
	Financial support from college	-------------

Blanks = no source identified.